HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA SILVER BOW COUNTY, MONTANA

Prepared For:

Montana Resources, LLP
Butte, Montana

Hydrometrics, Inc.
consulting scientists and engineers

JULY 2017

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Prepared for:

Montana Resources, LLP
600 Shields Avenue
Butte, MT 59701

Prepared by:

Hydrometrics, Inc.
3020 Bozeman Avenue
Helena, MT 59601

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF EXHIBITS

ABBREVIATIONS

ACC	Anaconda Copper Company
ARM	Administrative Rules of Montana
BGS	Below Ground Surface
BQM	Butte Quartz Monzonite
BMFOU	Butte Mine Flooding Operable Unit
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CSM	Conceptual Site Model
ft/day	feet/day
ft/ft	feet/feet
GPM	Gallons Per Minute
GWIC	Groundwater Information Center
KP	Knight Piésold Consulting
LCV	Lowland Creek Volcanics
MBMG	Montana Bureau of Mines and Geology
MR	Montana Resources, LLP
m/sec	Meters Per Second
RQD	Rock Quality Designation
USGS	United States Geological Survey
VWP	Vibrating Wire Piezometers
WED	West Embankment Drain
YDTI	Yankee Doodle Tailings Impoundment

EXECUTIVE SUMMARY

Montana Resources, LLP (MR) has been conducting detailed hydrogeologic and geotechnical investigations in the vicinity of the Yankee Doodle Tailings Impoundment (YDTI) since 2012 to support planning and design of proposed modifications to the impoundment. Planned modifications include construction of an embankment along the west side of the YDTI to allow storage of mine tailings generated by currently permitted mining activities. Part of the investigation program has focused on the hydrogeology immediately west of the YDTI, an area referred to as the West Ridge. The West Ridge hydrogeologic evaluation, conducted jointly by MR, Hydrometrics and Knight Piésold (KP), has included completion of 19 monitoring wells, 21 bedrock/overburden drillholes, 33 exploration test pits, and 22 exploration trenches. The investigation has also included water level and water quality monitoring, bedrock core logging, and an extensive aquifer testing program including a number of multi-day constant discharge pumping tests, a 14-day variable discharge pumping test, and more than 100 falling head and constant head packer tests. Based on the investigation results, groundwater elevations in the West Ridge bedrock groundwater system range from approximately 6490 feet to 6380 feet (ACC datum). The lower groundwater levels occur in the central portion of the ridge and are referred to as the groundwater potentiometric low. In addition, a deep fracture system has been identified with lower hydraulic heads as compared to the surrounding saturated bedrock. Subsequent drilling and testing show the fracture system is bounded by a number of low permeability geologic structures, and that hydraulic heads in the fracture system, referred to as the deep isolated fracture system, are sensitive to small variations in recharge. The groundwater potentiometric low and deep isolated fracture system represent the critical groundwater level for assessing long-term hydrodynamic containment of the YDTI water along the West Ridge.

The West Ridge aquifer testing results show the West Ridge bedrock groundwater system is a double porosity, semi-confined fracture flow system with bedrock hydraulic conductivity values on the order of 0.03 ft/day (10^{-7} m/sec). The West Ridge is traversed by several east-west trending geologic structures or shear zones typically accompanied by clay gouge. The shear zones act as restrictions to groundwater flow dividing the West Ridge bedrock into a number of semi-isolated blocks. The shear zones impart significant control on the West Ridge bedrock groundwater system and are responsible in part for the occurrence of the groundwater potentiometric low and the deep isolated fracture system.

The YDTI West Embankment design includes a number of elements intended to ensure that water from the YDTI does not migrate westward beyond the West Ridge, including a free draining upstream zone and a perimeter drain (the West Embankment Drain or WED). In addition, development of a tailings beach along the full length of the West Embankment is intended to force the tailings pond to the east away from the embankment. The WED is designed to maintain a phreatic surface at the WED below the West Ridge groundwater levels, thereby ensuring long-term hydrodynamic containment along the West Ridge. Based on results of the West Ridge hydrologic evaluation, the WED and West Embankment design are expected to maintain hydrodynamic containment under the ultimate planned tailings pond elevation of 6429 feet ACC.

Aquifer testing results, including a 14-day pumping test, indicate that hydraulic heads within the deep isolated fracture system are sensitive to small changes in recharge. An augmented recharge test performed on the deep isolated fracture system, where water was added to the fracture system at an average rate of 2.3 gpm over five days (19,935 gallons total), raised the fracture system hydraulic heads by more than 50 feet. The augmented recharge test results indicate that in the unanticipated event that the West Embankment and WED design may not maintain full hydrodynamic control along the West Ridge, an augmented recharge program involving the addition of water to the deep isolated fracture system at low rates, either continuously or intermittently, can ensure long-term hydrodynamic control for the YDTI.

HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA SILVER BOW COUNTY, MONTANA

1.0 INTRODUCTION

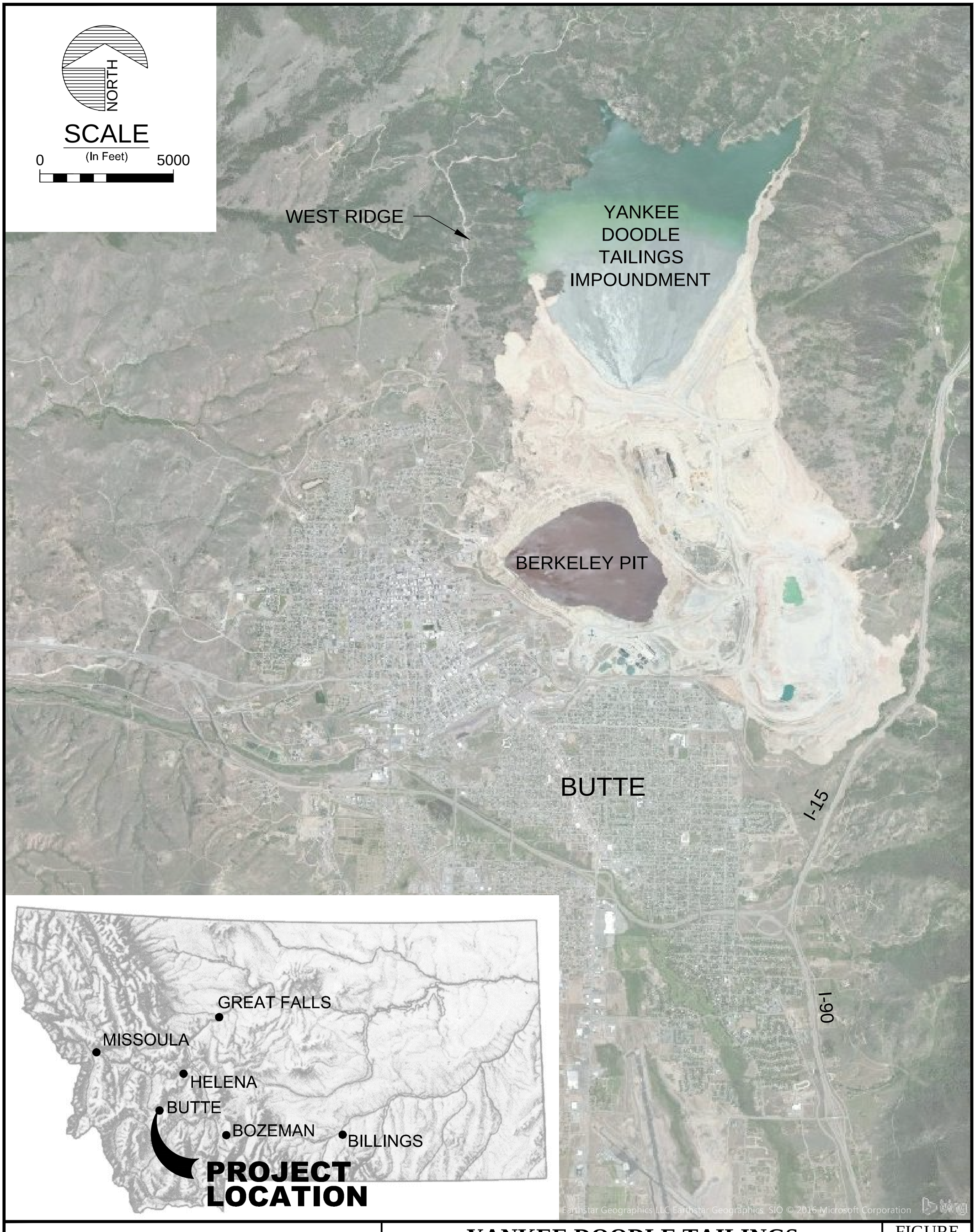
Montana Resources, LLP (MR) operates an open pit copper and molybdenum mine near the City of Butte in Silver Bow County, Montana. Mine tailings produced through the ore milling process are stored in the Yankee Doodle Tailings Impoundment (YDTI), a valley-fill style impoundment originally constructed in 1963. In order to accommodate future mining operations and provide continued containment of tailings, MR intends to increase the storage capacity of the impoundment by increasing the permitted impoundment elevation to 6450 feet. The modified impoundment will have a maximum operating pond level of approximately 6429 feet ACC[1]. In order to ensure that the YDTI continues to provide adequate containment of the mine process waters into the future, MR has undertaken an evaluation of hydrogeologic conditions in the vicinity of the impoundment, with emphasis on the area west of the impoundment. The area west of the YDTI, referred to as the West Ridge, is at a lower elevation than areas to the north and east, and is therefore considered to be more susceptible to potential seepage from the impoundment than other areas. At the request of MR, Hydrometrics has conducted an evaluation of hydrologic conditions in the vicinity of the YDTI with emphasis on the West Ridge (Figure 1-1).

This report presents results of the YDTI West Ridge hydrologic evaluation and provides information in support of MR's proposed YDTI embankment raise (operating permit amendment). The hydrologic evaluation was conducted in tandem with a geotechnical and hydrogeologic investigation completed in the area by Knight Piésold (KP), and information provided in this report should be reviewed in conjunction with other reports prepared by KP in support of the amendment design. The following sections describe the West Ridge investigation scope and results. Supporting technical information is included in appendices or referenced as appropriate.

1.1 STUDY AREA

The West Ridge area is a relatively low ridgeline bordering the west side of the YDTI. Ground elevations along the West Ridge range from about 6470 to 6550 feet ACC. The east flank of the ridge is a mixture of conifer/aspen forest with abundant granitic bedrock outcrops, and slopes relatively steeply towards the impoundment. The west flank slopes more gently due west and is mixed forest/open range land. Moulton Reservoir Road trends generally north-south along the ridge crest and a number of private residences are located along the west flank of the ridge. The West Ridge area, YDTI, and local relevant features are shown on Figure 1-2.

[1] All elevations presented in this report are relative to Anaconda Copper Company (ACC) vertical datum, which is approximately 57.15 feet higher than USGS datum.



HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA	**YANKEE DOODLE TAILINGS IMPOUNDMENT AND WEST RIDGE PROJECT AREA**	FIGURE **1-1**

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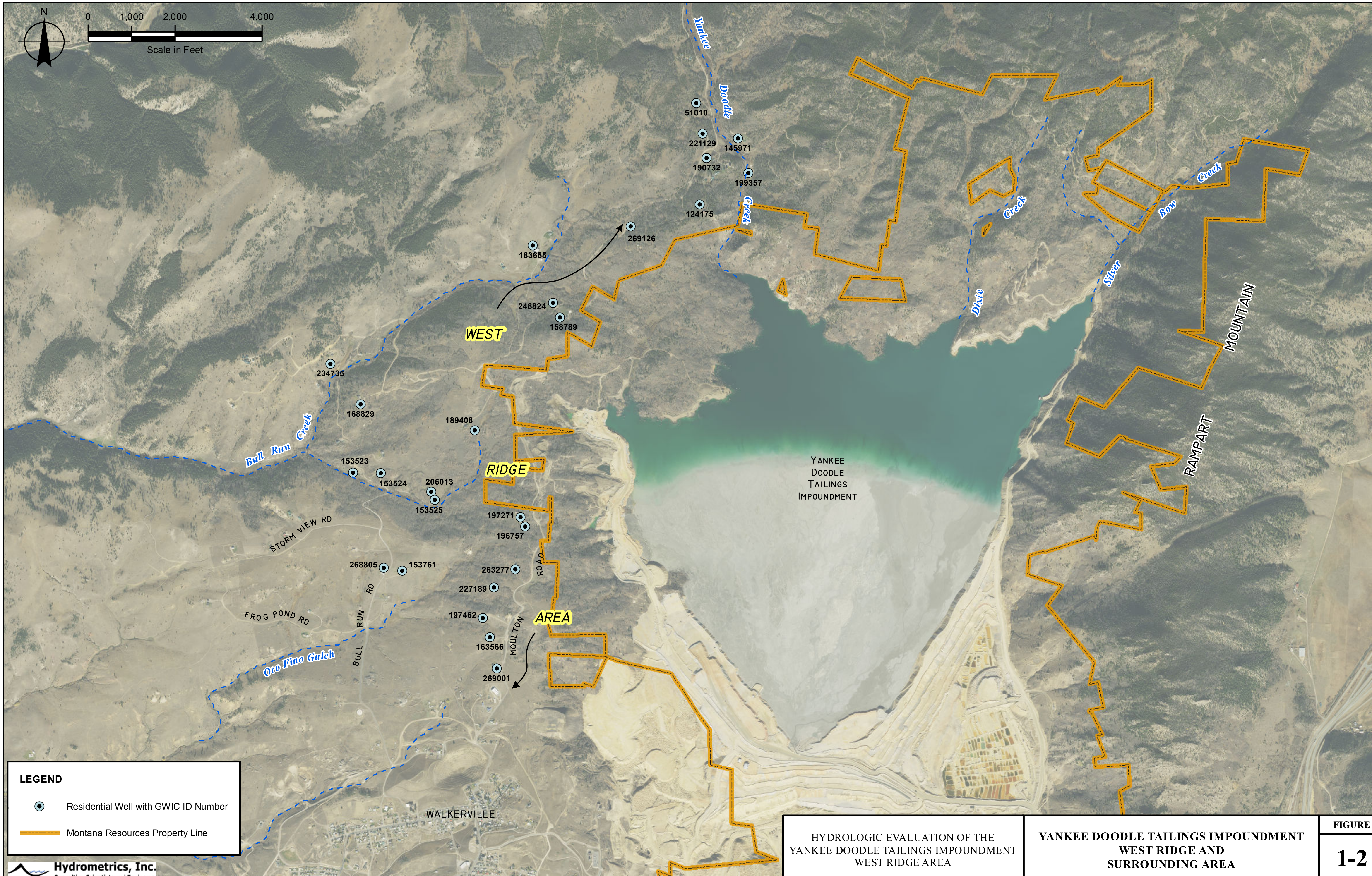

HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA

YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AND SURROUNDING AREA

FIGURE 1-2

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Surface water features are sparse along the east flank (impoundment side) of the ridge, with features limited to a few seeps and marshy areas. Two drainages, Bull Run Creek and Oro Fino Gulch drainage, occur on the west flank and although both drainages are perennial in their lower reaches, streamflow rates are relatively low.

Daily precipitation data is available from the Bert Mooney Airport weather station, located approximately six miles south of the YDTI and at elevation 5600 feet, about 800 feet lower in elevation than the impoundment. For the period 1990 through 2015, annual precipitation averaged 12.8 inches/year, ranging from 8.63 inches in 2000 to 19.96 inches in 1997 (Figure 1-3). Schafer (2016) developed an adjustment factor for the Bert Mooney Airport precipitation rates to the higher elevation YDTI. Based on this adjustment, annual precipitation in the YDTI and West Ridge area is estimated to be 15.9 inches/year.

FIGURE 1-3. ANNUAL PRECIPITATION FROM THE BERT MOONEY AIRPORT METEOROLOGICAL STATION IN BUTTE

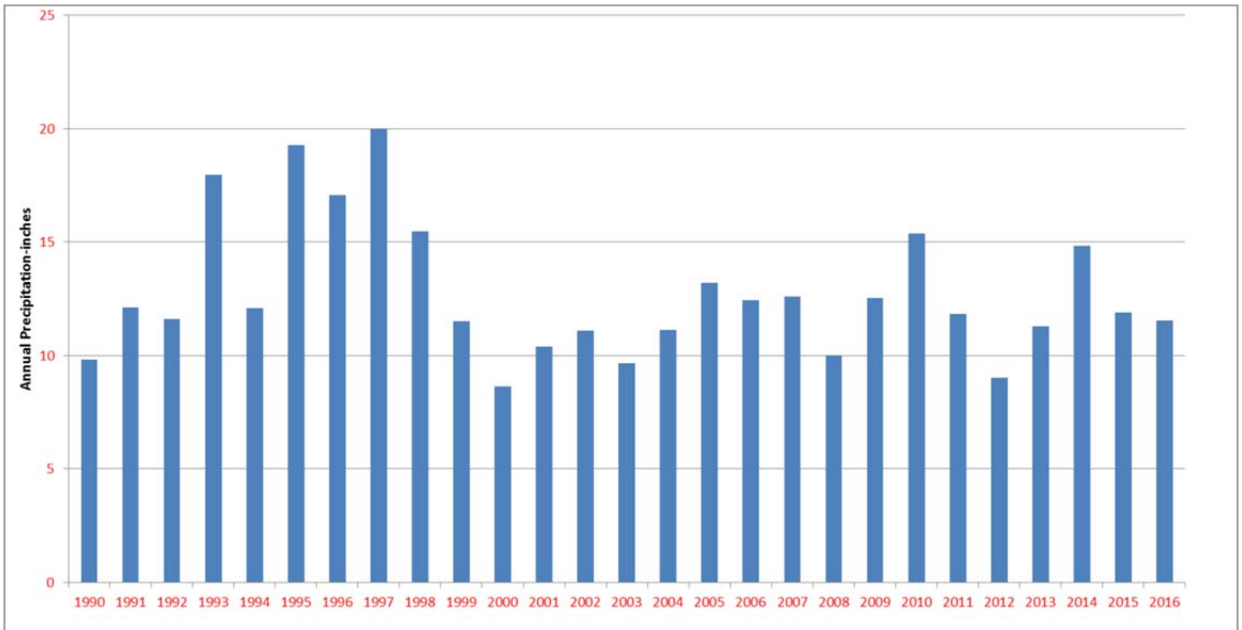


Figure 1-3. Annual Precipitation Recorded at the Bert Mooney Airport

2.0 SITE GEOLOGY

The regional geology of Butte and surrounding area has been described in numerous publications and is summarized in the mine operating plan (MR, 2016) and the YDTI Site Characterization Report (KP, 2017a). Geologic units within the project area include granitic bedrock associated with the Boulder Batholith, Lowland Creek Volcanics (LCV), and unconsolidated valley fill deposits. Following is a general description of the geologic units and structures in the vicinity of the YDTI. More detailed descriptions of the West Ridge geology, and its relevance to groundwater flow, are included in the following sections.

2.1 GEOLOGIC UNITS

2.1.1 Butte Quartz Monzonite

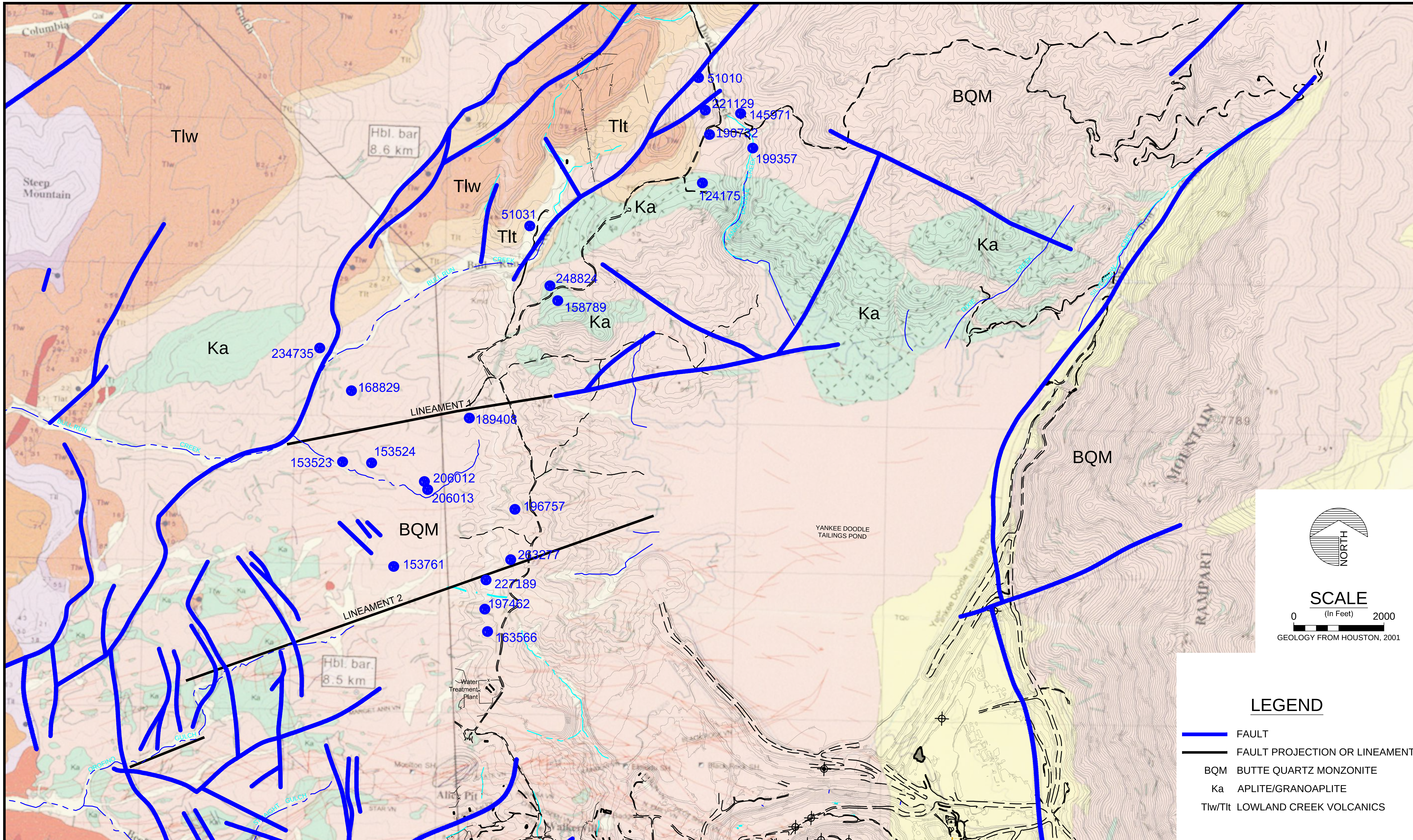
Bedrock geology in the vicinity of the YDTI is dominated by the granitic Butte Quartz Monzonite (BQM) phase of the Boulder Batholith (Figure 2-1). The Cretaceous age BQM is a medium grained hornblende-biotite quartz monzonite and forms the oldest and most abundant rock type in the district (Houston, 2001). The BQM composition includes abundant plagioclase, a mineral which tends to alter to clay when exposed to weathering or hydrothermal alteration. Boulder batholith rocks are mechanically homogeneous where intact, but jointing has created dominant planes of weakness that control rock behavior near the surface. The dominant joint sets are vertical and north-south trending, but other orientations exist (MBMG, 2009). The BQM is intruded by varying compositional phases of silica-rich aplite and granoaplite dikes and sills as well as pegmatite veins. The nature and occurrence of these various lithologic phases are of interest due to their potential influence on groundwater flow in the project area.

A distinct zone of highly weathered and altered bedrock occupies the upper few feet to tens of feet of BQM through most of the study area. The weathered bedrock typically consists of relatively fresh, quartz rich BQM clasts within an iron stained matrix of weathered/altered plagioclase and potassium feldspar minerals (KP, 2017a).

With the possible exception of the upper highly weathered zone, the BQM has very low primary porosity with groundwater flow associated with secondary features such as fractures, joints and other structural features. The BQM is the dominant water-bearing geologic unit peripheral to the YDTI including the West Ridge area.

2.1.2 Lowland Creek Volcanics

The tertiary age Lowland Creek Volcanics (LCV) overlie BQM north and west of the project area (Figure 2-1). LCV units present in the general area include the Basal Unit (Tlt) comprised of a basal ash tuff and detritus-rich conglomerate, and an overlying quartz-latite welded ash-flow tuff (Tlw). Houston (2001) reports that the LCV deposits are up to 700 meters thick north of the YDTI. The LCV typically are not considered to be significant water-bearing units due to their general lack of primary porosity. Based on these characteristics, and the lack of outcrops in the immediate vicinity, the LCV do not have a significant role in the YDTI and West Ridge area hydrogeology.



MONTANA RESOURCE PERMIT APPLICATION

GENERAL GEOLOGY OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT AREA AND WEST RIDGE

FIGURE 2-1

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2.1.3 Unconsolidated Deposits

Limited deposits of unconsolidated granular material, including alluvium and colluvium, occur in the project area. These deposits occur within the drainage bottoms located between the intervening ridges of BQM outcrops. KP characterized the unconsolidated material along the east side of the West Ridge through a series of test pits and trenches and report that the unit consists of dense silty sand with thicknesses ranging up to more than 16 feet in places, but generally less than 10 feet (KP, 2017a). The unconsolidated deposits overlie completely weathered bedrock, and the two have similar geotechnical and hydrological properties and are largely indistinguishable, except for the stratification typical of the alluvium/colluvium (KP, 2017a). Where investigated, the unconsolidated material was generally unsaturated.

More extensive deposits of alluvium/colluvium exist beneath the current YDTI, which was constructed over the confluence of Yankee Doodle and Silver Bow Creeks. Recent alluvium comprised primarily of silt and sand occupies the former Silver Bow Creek and Yankee Doodle drainages and tributaries and ranges up to 800 feet wide and 45 feet thick (Dames and Moore, 1963). Unconsolidated sediments ranging from silt up to cobble size underlie the extreme eastern portion of the YDTI between the former Silver Bow Creek channel and the East Ridge. This material is reportedly up to 80 feet thick along the eastern edge (Dames and Moore, 1963). The distribution of unconsolidated deposits along the West Ridge and now buried beneath the YDTI as documented through various investigations dating back more than 50 years have been compiled into a single map by KP (2017a). The resulting compilation reveals an extensive network of interconnected alluvial/colluvial deposits extending from west and north of the YDTI to the south. Although the surrounding alluvial/colluvial deposits do not play a significant role in the West Ridge hydrogeology, the buried drainage network may affect drainage patterns within the impoundment itself.

2.2 STRUCTURAL GEOLOGY

Of particular interest to the West Ridge hydrologic evaluation is the presence and characteristics of geologic structures within the bedrock. As with most granitic bedrock, the BQM has a low primary porosity and permeability with groundwater flow controlled by secondary features such as fractures, joint sets, mineralized veining and faulting. Following is a general discussion of the local structural geology with additional detail presented in relevant portions of this report.

2.2.1 Lineament Evaluation

One of the first steps completed in the West Ridge evaluation was review of potential lineaments traversing the West Ridge. Based on review of existing geologic maps and aerial photos, two lineaments were identified as potential geologic structures crossing the West Ridge (Hydrometrics, 2012). The first lineament (Lineament 1 on Figure 2-1) extends from the northwest portion of the YDTI (where an east-west oriented fault has previously been identified), westward to the head of Bull Run Creek drainage. Lineament 2 extends from the west impoundment abutment westward to the head of Oro Fino Gulch drainage. The two areas are described below.

Lineament 1

Lineament 1 extends from the northwest corner of the impoundment to the head of Bull Run Creek drainage (Figure 2-1). Based on the east-west trending fault previously mapped in the northwest portion of the impoundment, and its general alignment with the head of Bull Run Creek drainage, it appears likely that the fault extends westward through the West Ridge.

Besides the mapped fault on the east end and the aligned drainage on the west end of the apparent lineament, other indications of a cross-ridge bedrock structure in this area include a topographic low or saddle where the lineament crosses the ridge crest, and "gray decomposed clay" noted in a well log from a private water well located near the westward lineament projection. A low point or saddle in a ridge line typically indicates an area of increased bedrock erodibility, caused either by a change in lithology or the presence of a bedrock structure. Lacking any apparent change in lithology in the immediate area, the topographic saddle may indicate a structural feature trending through the area.

Figure 2-1 shows locations of residential water wells in the West Ridge area included in the Montana Bureau of Mines and Geology (MBMG) Groundwater Information Center (GWIC) database, with wells identified by their GWIC number. Well 189408 lies in close proximity to the fault projection through the West Ridge. The log from this well includes "Gray Decomposed Clay" from 45 to 200 feet, which may represent fault gouge. The static water level recorded on the well log (10 feet below ground surface (bgs)), is unusually high (i.e., shallow water table) while the recorded well yield (12 gpm), is also relatively high for the West Ridge area. The shallow groundwater may indicate that the bedrock structure acts as a restriction to groundwater flow, causing southward flowing groundwater to back up behind the fault, suggesting the well is located upgradient of the fault. In addition, groundwater level monitoring conducted during the West Ridge evaluation (Section 3.3) shows that groundwater levels are shallower, and show significantly greater seasonal fluctuation north of Lineament 1 than to the south (i.e., seasonal fluctuations of 25 feet in well MW12-13 to the north and 5 to 10 feet in wells to the south). These water level trends are consistent with the presence of a geologic structure coinciding with Lineament 1 restricting groundwater flow. As discussed further in this report, the presence of east-west oriented, low permeability structures cutting across the ridge heavily influence groundwater flow and recharge patterns throughout the West Ridge.

Lineament 2

Lineament 2 is located south of Lineament 1 and also trends northeast to southwest (Figure 2-1). Although no fault or other significant bedrock structures are identified on the geologic maps in this area, the strong linear pattern of upper Oro Fino Gulch drainage suggests the drainage pattern may be structurally controlled. The drainage is oriented approximately N50°E, which closely parallels the general NE-SW trending fault set present in the impoundment area. Although further surficial evidence of a ridge-crossing structure has not been identified in this area, projection of subsurface structures identified through the bedrock coring program does correlate well with the Lineament 2 trace (Section 4.2).

Numerous other structures of varying size and characteristics have also been identified through the West Ridge hydrologic evaluation as well as various prior regional studies. For the West Ridge, potentially significant features from a groundwater standpoint include aplite dikes, which tend to fracture under stress and could act as potential conduits, and numerous, predominantly east-west oriented "shear zones." The shear zones are typically associated with moderately to highly altered bedrock envelopes which restrict groundwater flow. A compilation of geologic structures is shown on Exhibit 1 with these features discussed further in relevant sections of the report.

3.0 HYDROLOGIC INVESTIGATION PROGRAM

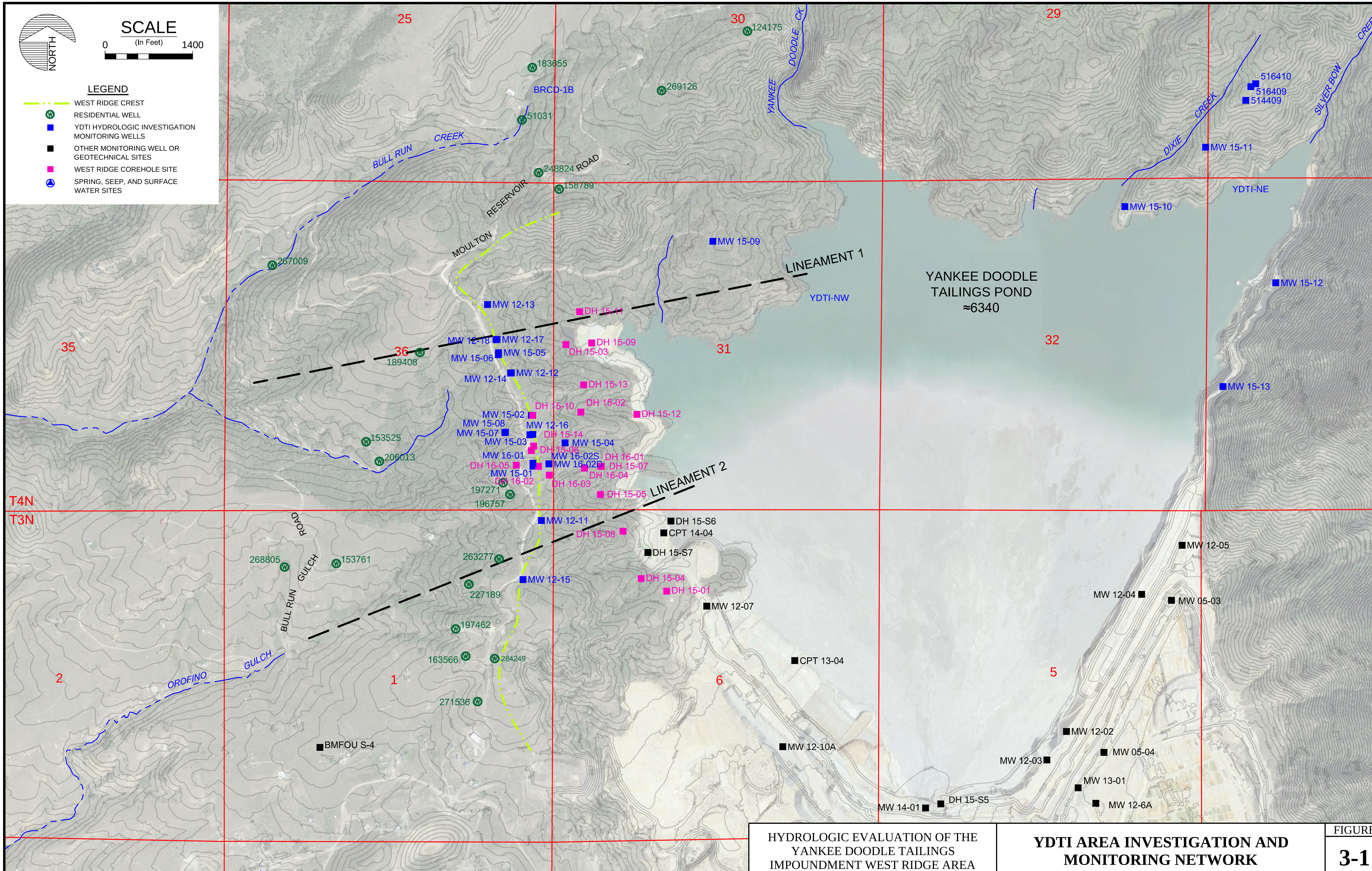
An extensive West Ridge hydrologic investigation and monitoring program has been conducted jointly by MR, KP, and Hydrometrics over the past few years with investigation results indicating the West Ridge bedrock groundwater system is a semi-confined system and the deep isolated fracture system confined. Components of the joint hydrologic evaluation include:

- Completion of 24 monitoring wells peripheral to the YDTI, with 19 of the wells located along the West Ridge;
- Completion of 19 bedrock diamond drillholes by KP for subsurface mapping, hydraulic packer testing, and installation of 73 vibrating wire piezometers (VWPs) at discrete intervals for continuous piezometric head monitoring;
- Excavation and logging of 33 test pits and 26 trenches by MR and KP for shallow mapping and hydrologic and geotechnical data collection;
- Water level and water quality monitoring in monitoring wells and local residential water supply wells;
- A spring/seep/surface water inventory and monitoring program; and
- A multi-phase aquifer testing program performed for estimation of bedrock hydrologic properties.

Individual components of the hydrologic investigation program are described below with interpretative results presented in Section 4.

3.1 MONITORING WELL DRILLING

Figure 3-1 shows the YDTI and the various environmental monitoring and testing locations throughout the impoundment area. Besides the project monitoring wells, Figure 3-1 shows other monitoring wells completed by MR for monitoring of the YDTI embankment and the mine area, the 19 bedrock drillholes completed by KP (KP, 2017a), local residential water supply wells, and surface water monitoring sites included in the hydrologic evaluation (although not part of the West Ridge evaluation, also shown on the figure are two sonic drillholes, DH15-S6 and DH15-S7, completed in the east-west embankment). In all, 24 monitoring wells have been drilled peripheral to the impoundment since 2012 as part of the current investigation program, 19 of which are located along the West Ridge (Figure 3-2). The purpose of the monitoring wells is to document groundwater depths and elevations along the West Ridge adjacent to the impoundment, evaluate bedrock characteristics relative to groundwater flow, and allow for collection of baseline groundwater chemistry data. Monitoring well completion details are presented in Table 3-1 and well completion logs are included in Appendix A.



HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA

YDTI AREA INVESTIGATION AND MONITORING NETWORK

FIGURE 3-1

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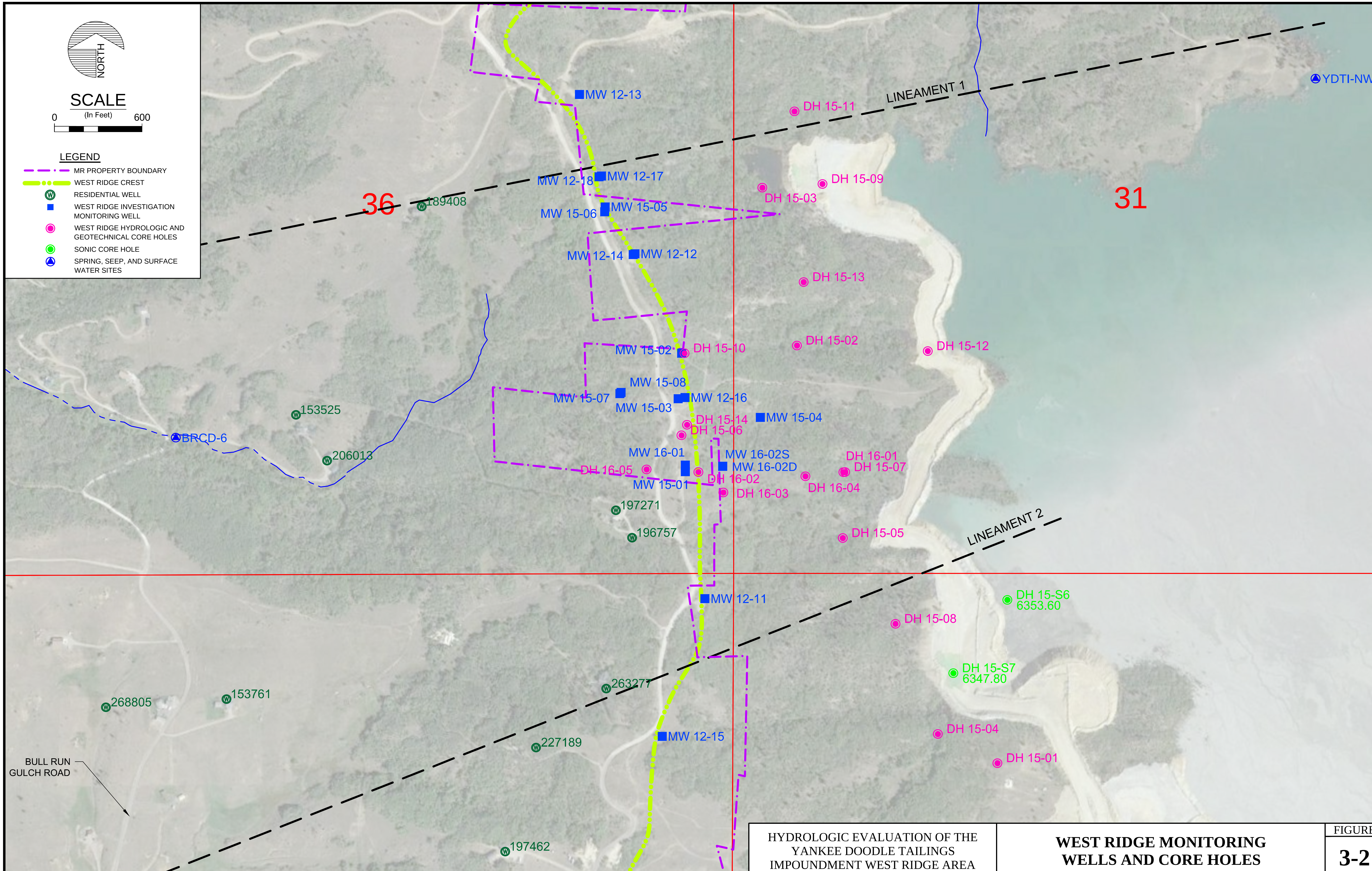

HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA

WEST RIDGE MONITORING WELLS AND CORE HOLES

FIGURE 3-2

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TABLE 3-1. WEST RIDGE MONITORING WELL COMPLETION DETAILS

Monitor Well	Northing	Easting	Ground Elevation	Measuring Point Elevation	MP Description	Stickup	Total Depth feet bgs	Screen Interval feet bgs	Sandpack Interval feet bgs
MW 12-11	144632.772	129595.697	6519.9	6521.408	4" pvc	1.5	200	145-195	140-200
MW 12-12	146995.712	129116.242	6475.6	6475.871	4" pvc	0.3	200	165-200	160-200
MW 12-13	148087.749	128735.882	6489.4	6490.277	4" pvc	0.9	200	150-200	145-200
MW 12-14	146991.142	129103.864	6475.5	6476.467	4" pvc	1.0	150	100-150	95-150
MW 12-15	143689.239	129303.030	6516.9	6518.900	6" Steel	2.0	200	150-200	NA
MW 12-16	146010.89	129459.45	6485.6	6487.579	4" pvc	2.0	191	141-191	134-191
MW 12-17	147529.03	128887.50	6471.6	6472.970	4" pvc	1.4	195	155-195	150-195
MW 12-18	147523.47	128870.45	6471.0	6472.649	4" pvc	1.6	115	80-115	74-115
MW 15-01	145502.70	129460.85	6501.5	6504.130	1" pvc	2.6	230	182-222	170-230
MW 15-02	146315.05	129436.01	6480.4	6483.340	1" pvc	2.9	197	147-197	141-199
MW 15-03	146002.63	129411.93	6484.8	6487.410	1" pvc	2.6	386	345-385	335-389
MW 15-04	145875.35	129974.90	6433.4	6435.980	1" pvc	2.6	220	170-220	163-220
MW 15-05	147317.32	128911.87	6466.1	6468.720	4" pvc	2.7	240	240-290	245-180
MW 15-06	147284.007	128909.305	6466.9	6468.965	4" pvc	2.1	400	350-400	336-400
MW 15-07	146037.876	129013.678	6462.2	6464.653	4" pvc	2.5	203	162.5-202.5	150-203
MW 15-08	146045.581	129020.815	6462.4	6464.574	4" pvc	2.2	102	81.5-101.5	72-102
MW 15-09	149096.971	132336.814	6453.2	6455.252	4" pvc	2.1	142	92-142	81-142
MW 15-10	149652.4088	138920.3052	6366.767	6368.9955	4" pvc	2.2	100	84-99	80-99
MW 15-11	150603.0217	140211.7817	6534.2143	6536.2988	4" pvc	2.1	201	161-201	154.5-201
MW 15-12	148433.935	141332.298	6433.7	6436.184	4" pvc	2.5	99	68.5-98.5	64-99
MW 15-13	146775.977	140488.142	6418.3	6420.829	4" pvc	2.5	101	81-101	79.5-101.5
MW 16-01	145547.761	129461.408	6499.677	6502.09	2" PVC	2	517	485-517	475-517
MW 16-02D	145539.9	129716.8	6497.878	6499.413	6" PVC	2.5	552	489-549	479-552
MW 16-02S	145539.8	129717.5	6497.878	6499.33	2" PVC	2.5	552	244-264	236-269

bgs-below ground surface

Well locations shown on Figure 3-2; well logs in Appendix A.

Horizontal coordinates in mine grid system; elevations relative to Anaconda Copper Company datum.

All program monitoring wells were drilled using conventional air rotary or dual rotary methods with total depths ranging from 99 feet to 547 feet. The wells were completed with Schedule 80 PVC casing and screen, ranging in size from 2-inch to 6-inch ID, 10/20 silica sand filter packs, and bentonite grout annular seals. All drilling and well completion activities were performed in accordance with State of Montana monitoring well completion regulations (ARM 36.21.800).

Wells installed during the initial phase of drilling (MW12-11 through MW12-15) were located based on the site topography and previously identified Lineaments 1 and 2 (Section 2.2). Subsequent monitoring wells were located based on findings from the initial well drilling and testing, including identification of an area of lower groundwater levels in the central portion of the ridge. At five locations, paired wells were completed at different depths to document vertical variability in hydraulic heads and bedrock interconnectivity. Paired well sets include MW12-12/12-14, MW12-17/12-18, MW12-16/15-03, MW15-05/15-06, MW15-07/15-08, and MW16-02S/16-02D (Figure 3-2).

3.2 BEDROCK DRILLING PROGRAM

KP completed an extensive bedrock drilling program in the West Ridge area to document subsurface bedrock conditions for geotechnical and hydrological purposes (KP, 2017a). A total of 19 diamond drillholes were completed in the West Ridge area with drilling footages ranging from 150 to 999 feet. The drilling utilized HQ3 or PQ3 equipment yielding continuous bedrock cores for lithologic and structural logging. Bedrock drillhole locations are shown on Figure 3-2 and details provided in Table 3-2. A detailed description of the drilling and logging program is included in KP (2017a).

As noted above and discussed further in this report, the first phase of monitoring well drilling identified an area of relatively low groundwater elevations at well MW12-16 in the central portion of the West Ridge (referred to as the potentiometric low). In late 2015, three angle drillholes were completed in this area to further evaluate the extent and potential causes of the lower groundwater levels. Angle drillholes DH15-06, DH15-10, and DH15-14 were drilled to lengths of 508, 700, and 700 feet, respectively (Table 3-2, Figure 3-2). The three angle holes, oriented approximately due north or south and spanning a total horizontal distance of approximately 800 feet, encountered numerous shear zones within the BQM characterized by altered bedrock envelopes and clay-rich gouge. Drillhole DH15-14 encountered a zone of fractured bedrock beneath a relatively thick shear zone, with anomalously low piezometric heads in the fracture zone. This fracture zone, referred to as the deep isolated fracture system, was the subject of an extensive investigation program in 2016 and is discussed at length in Sections 3 and 4.

In addition to the continuous core logging, packer tests were conducted in most diamond drillholes, and VWPs were installed at multiple depths to provide information on bedrock hydrologic properties and groundwater levels. This information is discussed in KP (2017a) and in relevant sections of this report.

TABLE 3-2. WEST RIDGE BEDROCK DRILLHOLE DETAILS

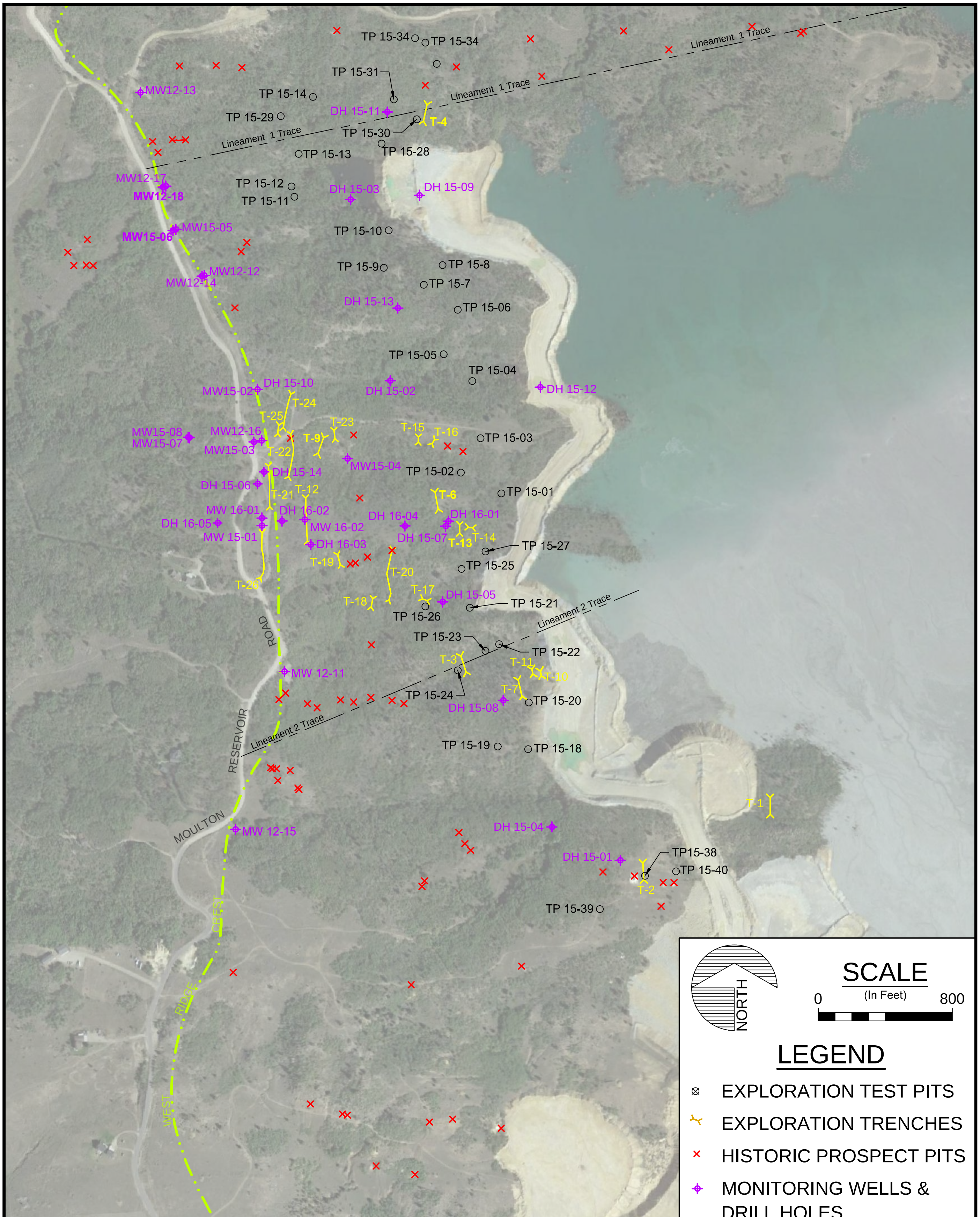
Drillhole Designation	Easting	Northing	Elevation	Azimuth	Dip	Total Depth	Installations
	(ft)	(ft)	(ft)	(°)	(°)	(ft)	
DH15-01	131,599.2	143,505.4	6,408.5	-	-	200	3 VWPs
DH15-02	130,226.2	146,367.3	6,374.1	-	-	300	3 VWPs
DH15-03	129,989.5	147,448.6	6,328.3	-	-	250	3 VWPs
DH15-04	131,190.9	143,704.6	6,351.4	-	-	200	3 VWPs
DH15-05	130,540.0	145,047.8	6,338.6	-	-	200	3 VWPs
DH15-06	129,435.4	145,751.8	6,485.3	360	64	508	5 VWPs
DH15-07	130,556.2	145,499.7	6,393.5	-	-	160	3 VWPs
DH15-08	130,900.9	144,460.3	6,399.9	-	-	193	3 VWPs
DH15-09	130,400.7	147,474.3	6,347.4	-	-	235	3 VWPs
DH15-10	129,455.8	146,314.1	6,481.5	181	64	700	5 VWPs
DH15-11	130,208.8	147,971.5	6,370.5	-	-	200	3 VWPs
DH15-12	131,122.0	146,329.3	6,347.6	-	-	150	3 VWPs
DH15-13	130,272.0	146,801.5	6,431.1	-	-	180	3 VWPs
DH15-14	129,473.3	145,823.7	6,483.4	181	64	700	5 VWPs
DH16-01	130,544.4	145,498.8	6,393.6	-	90	402	4 VWPs
DH16-02	129,550.9	145,500.1	6,502.3	181	73	602	3 VWPs
DH16-03	129,722.5	145,359.6	6,505.8	182	70	758	5 VWPs
DH16-04	130,284.3	145,471.0	6,469.5	175	71	850	6 VWPs
DH16-05	129,196.5	145,518.3	6,508.1	181	64	999	7 VWPs

NOTES:

1. Coordinate system and elevations are based on the Anaconda Mine Grid.
2 Azimuth and dip of drillholes based on MR drillhole survey. Drillhole dip varied slightly throughout the drillhole. The reported value represents the average dip along the drillhole length. The drillhole is vertical if no value is provided.
3. Azimuth includes magnetic declination correction of 11.9 E deg.
4. Information from KP, 2017a.

3.3 TEST PIT/TRENCHING PROGRAM

A test pit and trenching program was completed by KP and MR to investigate shallow subsurface hydrogeologic and geotechnical conditions along the east flank of the West Ridge. A total of 33 test pits and 26 trenches were excavated with a backhoe or excavator with test pit and trench locations shown in Figure 3-3. Information obtained from the test pit/trenching program included physical and geotechnical soil properties, depths to weathered and competent bedrock, weathered bedrock properties, and locations and orientations of geologic features such as mineralized veins, aplite dikes, and altered clayey shear zones. Information gained through this program regarding the distribution and characteristics of geologic structures, particularly the clay gouge shear zones, is critical to the development of a geologic model and associated interpretation of the West Ridge bedrock groundwater system (Section 4.2).



HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA

WEST RIDGE EXPLORATION TEST PIT AND TRENCH LOCATIONS

FIGURE

3-3

KP (2017a) presents results from the test pit/trenching program including the shallow subsurface stratigraphy and characteristics. Drainage channels along the east flank of the West Ridge contained 2 to 16 feet of loose to dense sand alluvium. Underlying the alluvium was weathered bedrock varying with depth from completely to moderately weathered. The completely weathered bedrock resembled alluvium in composition (80% sand/10% silt/10% clay) and varied in thickness from up to 10 feet in some drainage bottoms to 1 foot or less along ridge tops. KP (2017a) also conducted a number of infiltration tests to estimate the unconsolidated material (alluvium/colluvium/weathered bedrock) field saturated hydraulic conductivity. Results ranged from 3 to 50 ft/day ($1*10^{-5}$ to $2*10^{-4}$ meters/sec) with the one test on the completely weathered bedrock at the low end of the range.

3.4 GROUNDWATER LEVEL MONITORING

Maintaining hydrologic containment under a proposed maximum tailings pond elevation of 6429 feet ACC is largely dependent on maintaining water levels along the west side of the impoundment lower than groundwater elevations within the West Ridge. Consequently, monitoring of groundwater levels in the West Ridge monitoring wells and bedrock drillhole VWPs has been a key component of the West Ridge hydrologic evaluation. Groundwater level monitoring includes frequent manual measurements in each monitoring well, and continuous monitoring through placement of water level dataloggers in selected monitoring wells and VWPs in the bedrock drillholes.

Water level monitoring began in 2012 with completion of the first phase (MW12-series) monitoring wells. As previously noted, initial water level data showed that groundwater elevations were highest in the north and south portions of the West Ridge and lowest near the center of the ridge. The area of lower groundwater levels, referred to as the West Ridge potentiometric lowpoint, or low, is centered on monitoring well MW12-16 (Figure 3-2). The presence of the potentiometric low was not anticipated since initial conceptual models assumed that groundwater elevations would decrease steadily from north to south through the ridge due to the higher elevation, and presumed groundwater recharge source, to the north. Groundwater elevations at MW12-16 (completed to 200 feet bgs), and adjacent well MW15-03 completed in 2015 to a depth of 400 feet, have ranged from about 6375 to 6393 feet ACC seasonally. As noted in Section 3.2, three angle drillholes (DH15-06, DH15-10, and DH15-14) were completed by KP in the central ridge area in late 2015 to further investigate the extent and possible causes of the potentiometric low.

Hydrogeologic conditions encountered in DH15-06 and DH15-10, and in the first 650 feet of DH15-14, were consistent with those obtained from previous investigations with piezometric heads recorded in the VWPs correlating well with the monitoring well-derived potentiometric surface. Conditions below 650 feet in DH15-14, however, revealed a zone of highly fractured bedrock underlying a clay-gouge shear zone, with heads within the fracture zone lower than those in the surrounding bedrock system. Piezometric heads in this fracture zone as recorded by VWP1 and VWP2 were 6320 to 6340 feet ACC respectively, immediately after completion of drilling and have since increased to about 6365 and 6380 feet, respectively. This deep, low head fracture system encountered in DH15-14, referred to as the deep isolated fracture system for reasons described in subsequent sections of this report, presented a second area of lower hydraulic heads leading to further investigations focused on the central West Ridge area.

3.4.1 Current Groundwater Elevations

Table 3-3 summarizes the 2016 through June 2017 seasonal water level trends at the West Ridge monitoring wells. Due to completion of several of the wells in mid to late 2015, the 2016-2017 period provides the most complete static water level dataset, although the 2016 levels at some sites were affected by various drilling and testing activities. Of particular note, water levels in well MW15-01 were affected by drilling of MW16-01, MW16-02S, and MW16-02D from March through June 2016. Likewise, water levels in wells MW16-01 and MW16-02D were still increasing as of June 2017 following the long-term pumping and recharge testing conducted through October 2016.

As noted above, depths to groundwater are shallowest in the northern and southern portions of the ridge and deepest in the central portion. The shallowest groundwater occurs at northern-most well MW12-13 where 2016/17 depths to groundwater ranged from 8.7 feet in June to 29.7 feet in March. At the south portion of the ridge, groundwater depths at MW12-15 ranged from 33.6 feet to 37.5 feet with the shallowest depths occurring in June and the deepest occurring in November. The greatest depths to water, ignoring the pumping-induced water levels at MW16-01 and MW16-02D, were observed at MW15-03 (102.1 to 110.7 feet), located adjacent to MW12-16 where the groundwater potentiometric low was originally identified in 2012. Groundwater elevations throughout the ridge generally follow the same trends as groundwater depths with the highest groundwater elevations at southernmost well MW12-15 (average 6483 feet) and the second highest at northern well MW12-13 (average 6472 feet). Groundwater elevations were lowest at central area wells MW12-16 and MW15-03, with 2016/17 average elevations of 6383 and 6380 feet, respectively. The greatest seasonal fluctuation, 25.2 feet, again ignoring the pumping-induced water levels at wells MW16-01 and MW16-02D, occurred at wells MW12-14 and MW12-13 (Table 3-3). As noted in Section 2.2, the shallow groundwater levels and larger seasonal fluctuations at MW12-13 are believed to be due to the structure associated with Lineament 1. MW12-13 is located immediately north of Lineament 1, which is believed to restrict flow, causing groundwater to back up north (upgradient) of the structure. Water level fluctuations are least in the southern part of the ridge with seasonal fluctuations of less than 6 feet at south wells MW12-15 and MW12-11.

As previously noted, monitoring wells MW16-01 and MW16-02D are completed in the deep isolated fracture zone identified by angled drillhole DH15-14. Water levels in the deep fracture zone were influenced significantly by the 2016 drilling activities and subsequent pumping and recharge tests. Consequently, piezometric conditions within the fracture zone were still equilibrating as of June 2017 with water levels increasing by approximately 0.03 feet per day. As of completion of this report, groundwater elevations in MW16-01 and MW16-02D were both approximately 6380 feet. Characterization of the deep fracture zone is discussed further in Section 3.5 and Section 4.

TABLE 3-3. 2016/17 GROUNDWATER LEVEL TRENDS FOR WEST RIDGE MONITORING WELLS

Monitoring Wells				2016-June 2017 Depth to Groundwater				2016-June 2017 Groundwater Elevations		
Site	Top of Casing Elevation	Screen Interval Depth bgs	Notes	2016/17 Average	Min	Max	Range	2016/17 Average	Max	Min
MW 12-13	6490.28	150-200		18.2	8.7	29.7	21.1	6472.0	6481.6	6460.6
MW 12-17	6472.97	155-195	Paired Wells	38.0	32.1	40.7	8.6	6435.0	6440.9	6432.3
MW 12-18	6472.65	80-115		37.0	25.5	41.0	15.5	6435.7	6447.2	6431.7
MW 15-05	6468.72	240-290	Paired Wells	33.8	26.7	36.3	9.6	6434.9	6442.1	6432.5
MW 15-06	6468.97	350-400		39.9	33.9	42.3	8.4	6429.1	6435.1	6426.7
MW 12-12	6475.87	165-200	Paired Wells	46.8	37.6	50.7	13.0	6429.1	6438.3	6425.2
MW 12-14	6476.47	100-150		38.2	21.7	47.0	25.2	6438.3	6454.7	6429.5
MW 15-02	6483.34	147-197		70.2	56.4	75.0	18.7	6413.1	6427.0	6408.3
MW 15-07	6464.65	162-202	Paired Wells	72.2	62.9	75.7	12.8	6392.4	6401.8	6389.0
MW 15-08	6464.57	81-101		60.2	46.9	64.2	17.2	6404.4	6417.6	6400.4
MW 12-16	6487.58	141-191	Paired Wells	104.3	100.0	108.6	8.6	6383.2	6387.6	6379.0
MW 15-03	6487.41	345-385		107.0	102.1	110.7	8.6	6380.4	6385.3	6376.7
MW 15-04	6435.98	170-220		53.0	44.4	64.3	20.0	6382.9	6391.6	6371.7
MW16-01[1]	6502.09	485-517		140.0	80.1	287.5	207.4	6362.1	6422.0	6214.6
MW16-02D[1]	6499.41	489-549	Paired Wells	146.4	68.0	404.1	336.1	6358.2	6431.4	6095.3
MW16-02S	6499.33	244-264		65.0	56.1	71.5	15.4	6434.4	6443.3	6427.9
MW 15-01[2]	6504.13	182-222		68.8	60.8	74.7	13.9	6435.3	6443.4	6429.5
MW 12-11	6521.41	145-195		59.2	54.9	60.4	5.5	6462.3	6466.5	6461.1
MW 12-15	6518.90	150-200		35.6	33.6	37.5	4.0	6483.3	6485.4	6481.4

Wells listed in north to south direction; locations shown on Figure 3-2.

bgs-Below Ground Surface

Groundwater depths in feet from top of well casing.

1 - MW16-01 and 16-02D completed in deep isolated fracture system in 2016; water levels affected by drilling and aquifer testing. Water levels continuing to increase at the time of reporting.

2 - MW15-01 data limited to August 2015 through March 2016; earlier and later data affected by nearby drilling.

All measurements recorded to nearest 0.01 feet. Complete dataset included in Appendix B.

All elevations relative to ACC Datum.

Figures 3-4 and 3-5 show the seasonal groundwater potentiometric maps for the West Ridge bedrock groundwater system based on the June/July and October 2016 monitoring well water level data. The water level trends described above are evident on the potentiometric maps with groundwater elevations greatest in the south and north portions of the West Ridge, and lowest in the central portion at wells MW12-16 and 15-03 at the previously described potentiometric low. Note that the potentiometric maps represent groundwater conditions within the main West Ridge bedrock groundwater system and do not depict water levels in the deep isolated fracture system. Figure 3-6 includes a north-south-oriented cross section along the West Ridge crest with the June 2017 groundwater levels shown. The lower groundwater levels associated with the potentiometric low centered on wells MW12-16 and MW15-03, and the deep isolated fracture system defined by water levels in MW16-01 and DH15-14 VWP1 and 2, are evident on the cross section.

3.4.2 Vertical Hydraulic Gradients

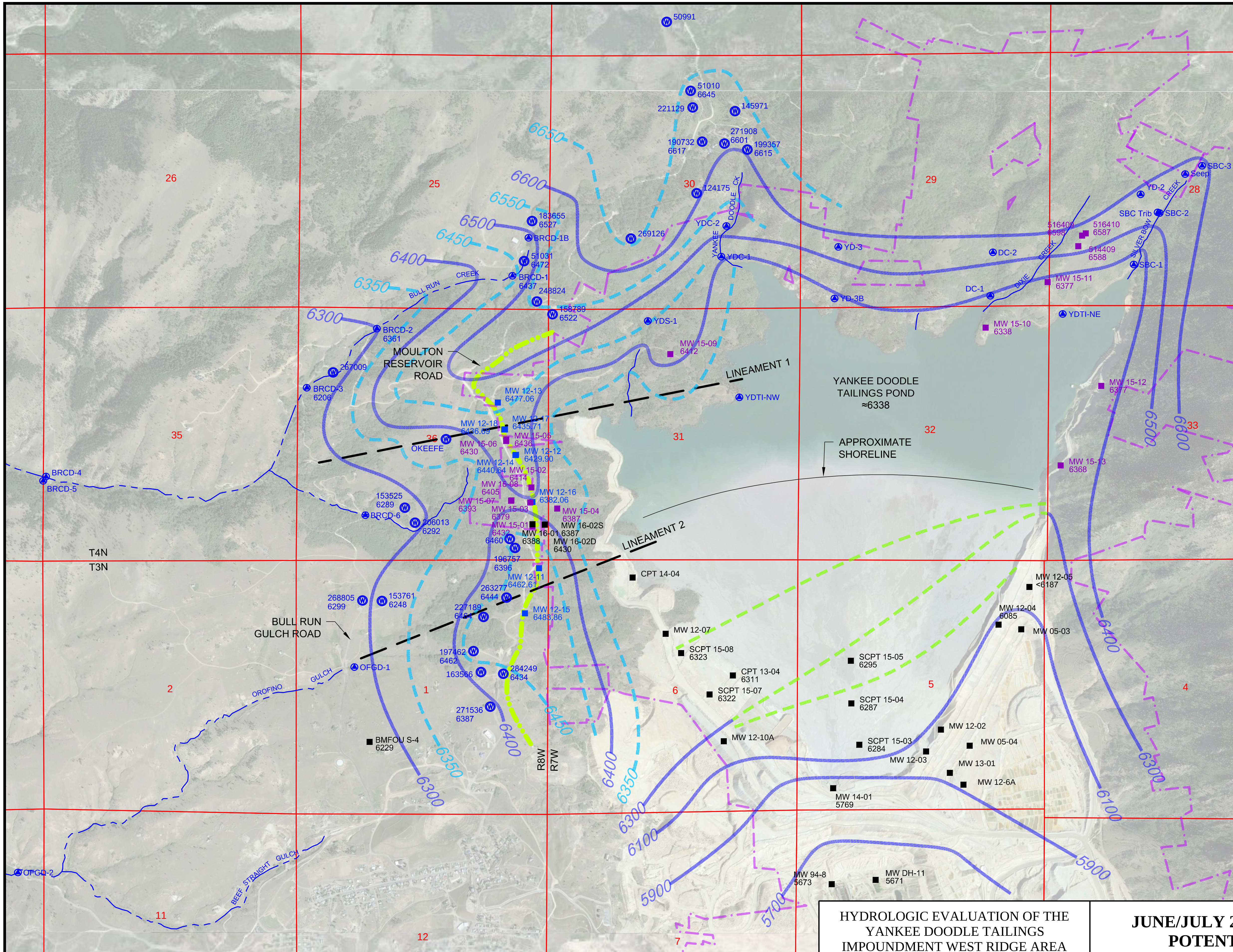
As noted above, paired wells (adjacent wells screened at differing depths) were completed at six locations to evaluate vertical hydraulic gradients within the bedrock groundwater system. Well pairs include, from north to south, MW12-17/12-18, MW15-05/15-06, MW12-12/12-14, MW15-07/15-08, MW12-16/15-03, and MW16-02S/16-02D. Paired wells were completed where initial drilling indicated some variability with depth in bedrock and/or hydrologic conditions, such as increased fracturing, or changing well yields or depths to water. The well pairs and corresponding water level data are listed in Table 3-4 with well locations shown on Figure 3-7.

Seasonal vertical gradients at all six sites are downward or neutral based on the June 21, 2016, November 22, 2016, and June 16, 2017 groundwater elevations, with the following observations:

- At the two northern-most well pairs (MW12-18/12-17 and MW15-05/15-06), downward gradients are low or near neutral (-0.08 ft/ft or less) with little seasonal variation. Immediately to the south at MW12-12/12-14, seasonal vertical gradients show more seasonal variability with a downward gradient of -0.29 in June 2017 and -0.03 in November 2016.

- In the central portion of the ridge near the potentiometric low, vertical gradients are neutral at wells MW12-16 and MW15-03 (-0.01 to -0.02). Immediately to the west at MW15-07/15-08, vertical gradients are downward and range from -0.11 in November 2016 to -0.17 in June 2017. The greater vertical gradient at MW15-07 and 15-08 corresponds to the shallower portion of the groundwater system (100 to 200 foot depth), while the MW12-16/15-03 gradients represent conditions in the 200 to 400 foot depth interval.

- The pumping-affected conditions at well MW16-02D in 2016, completed in the deep isolated fracture system, preclude quantification of vertical gradients with well MW16-02S, completed vertically above the fracture zone. However, based on the June 2017 data, a downward gradient of -0.24 ft/ft exists between the deep fracture system and overlying saturated bedrock. Despites the significant downward gradient, the presence of clay-rich shear zones and/or competent bedrock between the two well screen sections minimizes the potential for vertical flow between these two units (see Sections 3.5.3 and 4.3).



NORTH

SCALE

0 (In Feet) 2000

LEGEND

	WEST RIDGE CREST
ⓦ	RESIDENTIAL WELL WITH JUNE/JULY 2016 GROUNDWATER ELEVATION
■	MONITORING WELL WITH JUNE/JULY 2016 GROUNDWATER ELEVATION
▲	SPRING, SEEP, AND SURFACE WATER SITES
	BEDROCK GROUNDWATER POTENTIOMETRIC CONTOURS
	TAILINGS POTENTIOMETRIC CONTOURS

HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA	**JUNE/JULY 2016 GROUNDWATER POTENTIOMETRIC MAP**	FIGURE **3-4**

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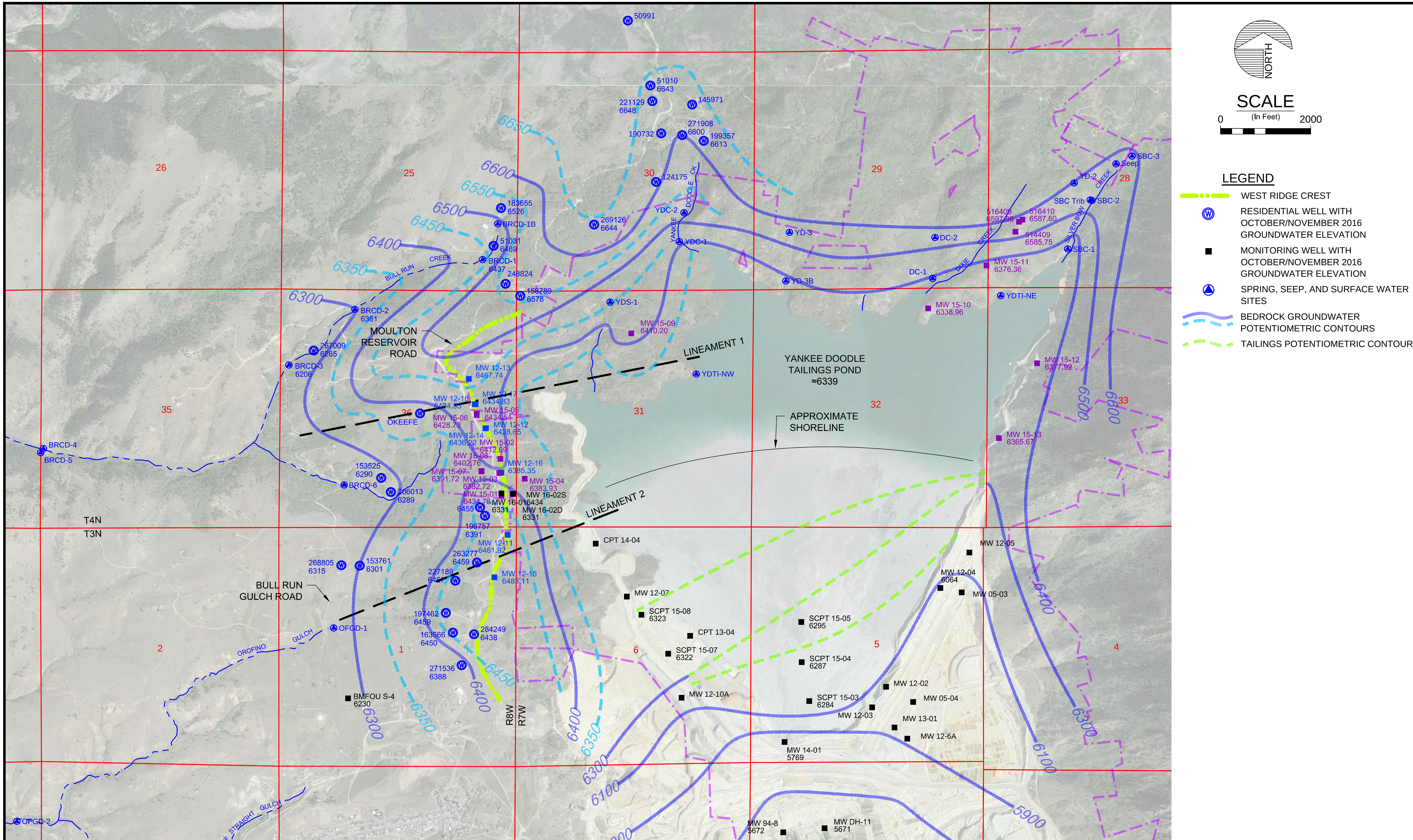

HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA

OCTOBER/NOVEMBER 2016 GROUNDWATER POTENTIOMETRIC MAP

FIGURE 3-5

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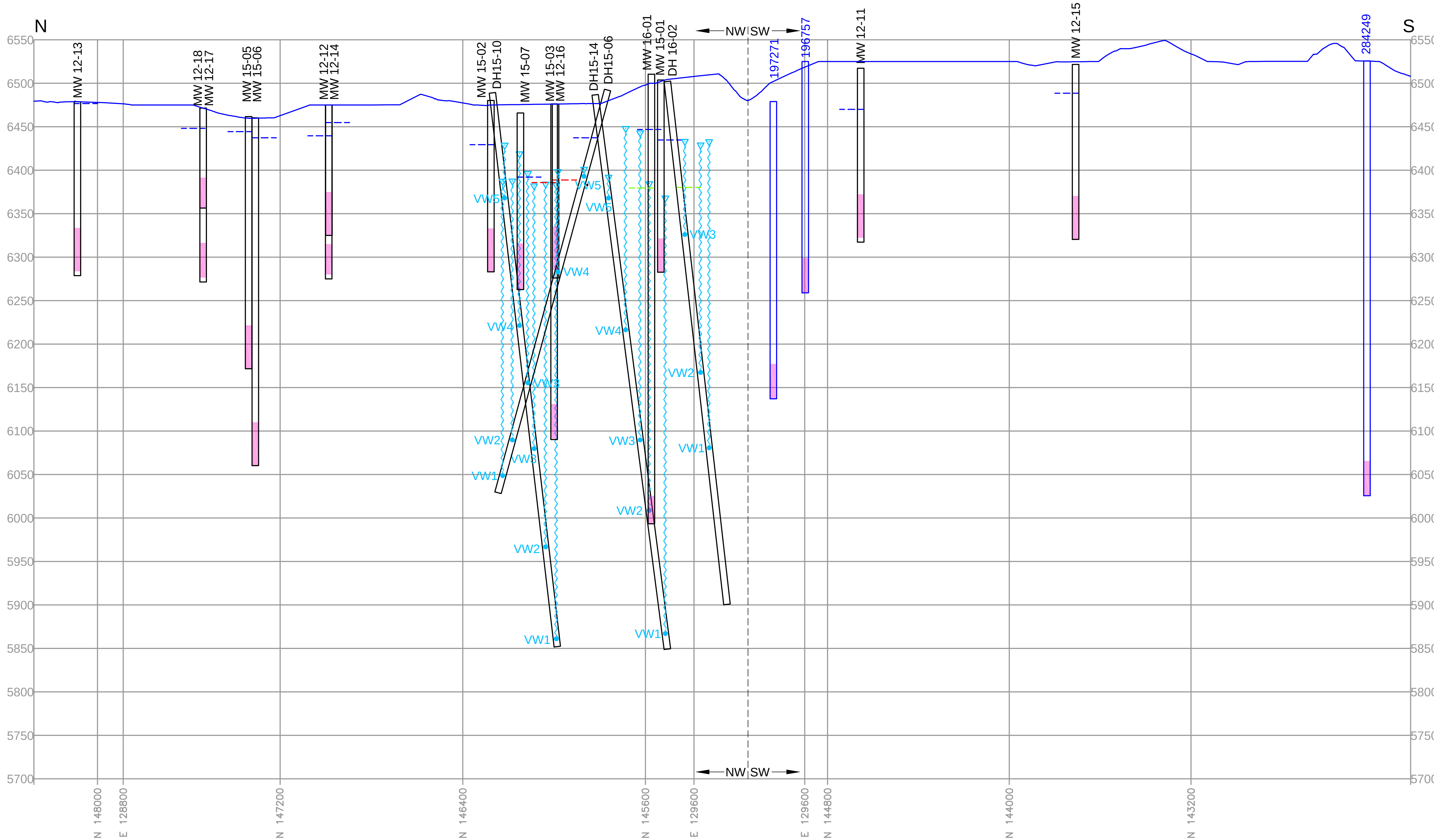

LEGEND

DH 15-10 — CORE HOLE WITH VIBRATING WIRE PIEZOMETER LOCATION (VW1)

MW 12-15 — MONITORING WELL WITH JUNE 2017 GROUNDWATER LEVEL

197271 — PRIVATE DOMESTIC WELL

GROUNDWATER POTENTIOMETRIC LOW WATER LEVEL

DEEP FRACTURE SYSTEM WATER LEVEL

SCALE

0 (In Feet) 500

(H) 1"=500' (V) 1"=125'

HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA

NORTH-SOUTH WEST RIDGE CROSS SECTION WITH GROUNDWATER LEVELS

FIGURE

3-6

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TABLE 3-4. WEST RIDGE PAIRED WELLS AND VERTICAL HYDRAULIC GRADIENTS

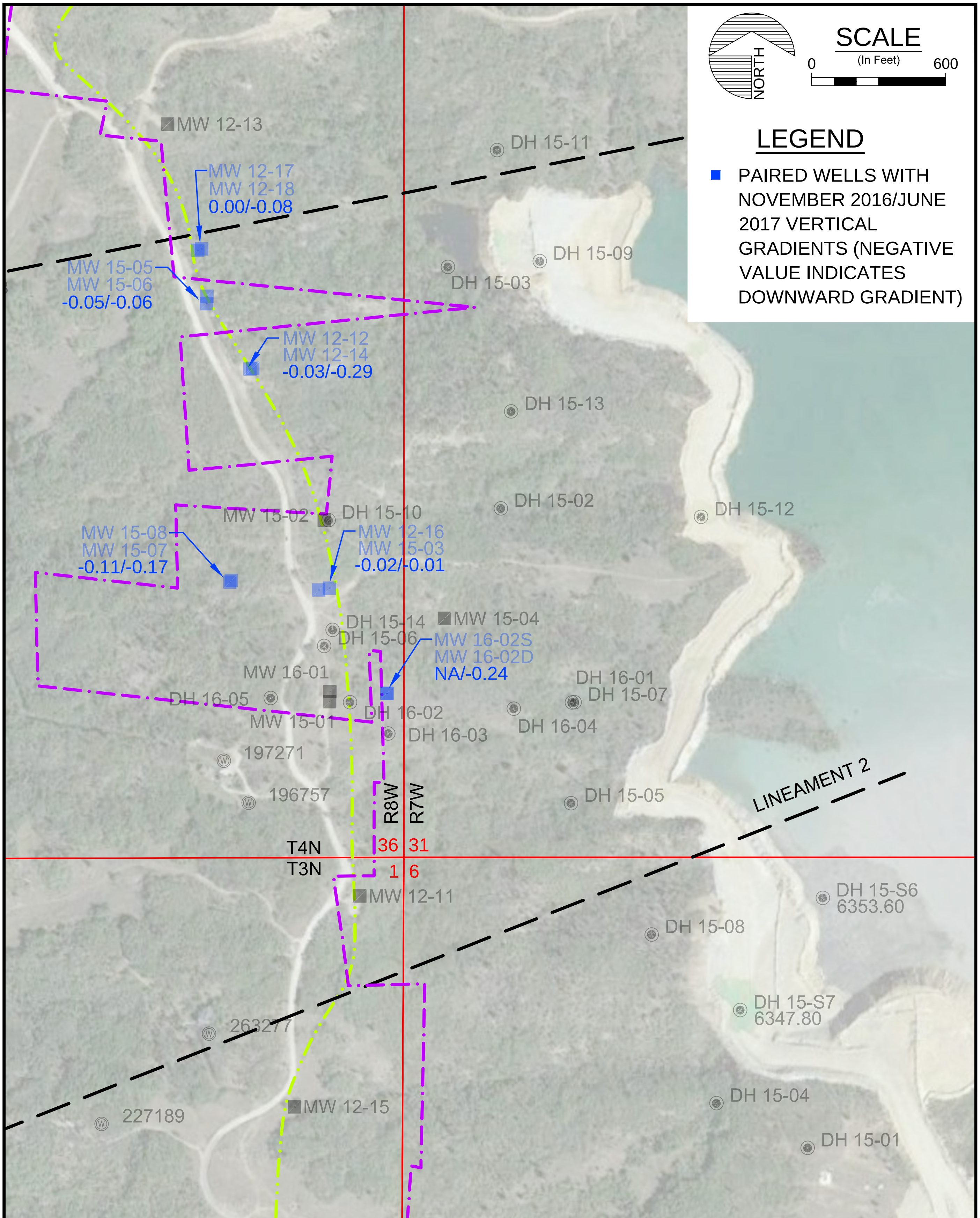
Site	Top of Casing Elevation-feet	Screen Interval Depth feet bgs	Groundwater Elevations-feet		
			6/21/2016	11/22/2016	6/16/2017
North Area					
MW 12-18	6472.65	80-115	6436.45	6434.48	6447.20
MW 12-17	6472.97	155-195	6435.39	6434.77	6440.9198
		Head Difference	1.06	0.29	6.28
		Vertical Gradient ft/ft	*-0.01*	*0.00*	*-0.08*
MW 15-05	6468.72	240-290	6435.47	6434.16	6442.05
MW 15-06	6468.97	350-400	6429.63	6428.44	6435.10
		Head Difference	5.85	5.72	6.95
		Vertical Gradient ft/ft	*-0.05*	*-0.05*	*-0.06*
MW 12-14	6476.47	100-150	6440.75	6429.49	6454.73
MW 12-12	6475.87	165-200	6430.46	6427.77	6438.25
		Head Difference	10.29	1.72	16.48
		Vertical Gradient ft/ft	*-0.18*	*-0.03*	*-0.29*
Central Area					
MW 12-16	6487.58	141-191	6381.66	6385.75	6387.61
MW 15-03	6487.41	345-385	6378.76	6382.13	6385.29
		Head Difference	2.90	3.62	2.32
		Vertical Gradient ft/ft	*-0.01*	*-0.02*	*-0.01*
MW 15-08	6464.57	81-101	6405.49	6402.57	6417.64
MW 15-07	6464.65	162-202	6392.71	6392.32	6401.80
		Head Difference	12.78	10.25	15.84
		Vertical Gradient ft/ft	*-0.14*	*-0.11*	*-0.17*
MW16-02S	6499.33	236-269	6430.33	6434.20	6443.26
MW16-02D	6499.413	479-552	6387.14	6344.78	6379.89
		Head Difference	43.19	89.42	63.37
		Vertical Gradient ft/ft	*See Note 1*		*-0.24*

1 - MW16-02D water levels affected by drilling and pumping; current levels not in equilibrium.
Existing information indicates significant downward gradient.

bgs-Below Ground Surface

Negative value indicates downward gradient.

Vertical distances measured between center of well screens.



HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA

PAIRED WELL LOCATIONS AND VERTICAL HYDRAULIC GRADIENTS

FIGURE **3-7**

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Water level data recorded during sampling of the paired wells provides insight into the vertical interconnectivity between the well screen intervals and continuity of the bedrock groundwater system with depth. Appendix B includes continuous water level hydrographs recorded with pressure transducers for each monitoring well. With the exception of MW16-02D and MW16-02S, hydrographs for the paired wells show that the water level in each well responds to pumping (well purging) during sampling of the adjacent paired well. This indicates that the bedrock groundwater system is continuous to the depths of monitoring well (and bedrock drillhole) completion (over 500 feet) as opposed to the multiple distinct intervals of saturated bedrock with depth.

3.5 AQUIFER TESTING

Hydrologic properties in the West Ridge bedrock system have been evaluated through a multi-phase aquifer testing program. The testing program included:

- Slug tests performed on select monitoring wells spanning the West Ridge to provide preliminary estimates of the BQM bedrock system hydraulic conductivity;

- Multi-day constant discharge pumping tests conducted on monitoring wells MW15-01, MW15-02 and MW12-18 to provide more detailed estimates of the bedrock groundwater system hydraulic properties;

- A long-term (14-day) variable discharge pumping test conducted on monitoring well MW16-02D completed in the deep isolated fracture system; and

- A total of 116 falling head and constant head packer tests conducted by KP on the diamond drillholes to assess vertical variability in the bedrock groundwater system hydraulic conductivity.

Each of these aquifer testing program components is described below. Results of an augmented recharge test, where water was added to the deep isolated fracture system and the fracture system and surrounding water levels monitored, are presented in Section 4.5 as part of a conceptual groundwater mitigation program that could be implemented if future conditions warrant.

3.5.1 Preliminary Slug Tests

Slug tests were conducted on seven of the West Ridge monitoring wells in conjunction with well development to provide preliminary estimates of the bedrock hydraulic conductivity. Slug testing involved raising and/or lowering the water level by placing a solid slug into the water column or pumping water from the well and monitoring the water level recovery either manually or with a transducer/datalogger. The slug test data were analyzed using the AQTESOLV software package and the Bouwer-Rice analytical Method (Kruseman and de Ridder, 1990).

The preliminary slug testing information is summarized in Table 3-5. As shown in the table, the hydraulic conductivity values range from 0.07 to 1.62 ft/day ($2.5*10^{-7}$ to $5.7*10^{-6}$ meters/sec). Water level displacements ranged from 5 to 10 feet, and recovery monitoring periods from 10 to 60 minutes. Not shown in Table 3-5 are results of a slug test on well MW12-18, a relatively shallow well completed from 80 to 115 feet bgs and located immediately south of Lineament 1 (Figure 3-2). Slug test results for this well include a hydraulic conductivity of 13.6 ft/day ($4.8*10^{-5}$ meters/sec), anomalously high for the West Ridge bedrock groundwater system. In response to the anomalous slug test result, a multi-day constant discharge pumping test was subsequently conducted on the well (Section 3.5.2), with resulting hydraulic conductivity values two orders of magnitude lower than the slug test results. Due to the longer duration and greater hydraulic stresses imposed by the pumping test, and the generally greater reliability of pumping test results as compared to slug tests, the slug test results for MW12-18 were deemed non-representative of regional bedrock conditions and were not utilized in the hydrogeologic evaluation. Although considered preliminary due to the limited volume of bedrock influenced by slug testing, the rest of the slug test results are consistent with the other aquifer testing program results and are considered representative of local bedrock conditions.

TABLE 3-5. PRELIMINARY SLUG TESTING RESULTS FOR THE WEST RIDGE BEDROCK GROUNDWATER SYSTEM

Well	Well Screen Interval	Water Column Displacement	Monitoring Duration	Hydraulic Conductivity	
	feet bgs	feet	minutes	feet/day	meters/sec
MW12-11	145-195	6.5	60	0.32	$1.1*10^{-6}$
MW12-12	165-200	5.0	45	1.49	$5.2*10^{-6}$
MW12-13	150-200	10.2	50	0.26	$9.2*10^{-7}$
MW12-14	100-150	6.0	18	0.80	$2.8*10^{-6}$
MW12-15	150-200	4.0	10	1.62	$5.7*10^{-6}$
MW12-16	141-191	4.5	32	1.30	$4.6*10^{-6}$
MW12-17	145-195	9.5	32	0.07	$2.5*10^{-7}$

bgs – below ground surface

3.5.2 Constant Discharge Pumping Tests

Constant discharge pumping tests were performed on West Ridge monitoring wells MW15-01, MW15-02, and MW12-18 in 2015. The constant discharge testing protocol included:

- Recording background (pre-pumping), pumping period, and post pumping recovery water levels in the pumping well and observation wells with automated water level dataloggers;

- Piping and discharge of pumped water a minimum 500 feet downhill (east) of the pumping and observation wells to minimize potential infiltration and recirculation of discharge water;

- Recording pumping rates and total volumes pumped with a mechanical (impeller) flow meter with digital readout and datalogger with periodic volumetric measurements for verification; and

- Periodic collection of water samples from the pumping well during each test to document potential changes in water chemistry indicating variations in recharge sources.

The constant discharge pumping test details are summarized in Table 3-6 and complete test data included in Appendix C.

MW15-01 Pumping Test

Monitoring well MW15-01 is located in the central portion of the West Ridge near the ridge crest (Figure 3-2). MW15-01 is located about 500 feet south of MW12-16, the location of the potentiometric low, but does not exhibit similar lower water levels (groundwater elevations at MW15-01 average about 6430 feet compared to 6380 feet at MW12-16), thereby constraining the southern extent of the potentiometric low. MW15-01 was selected for pump testing to provide information on potential hydraulic interconnectivity south of the potentiometric low.

The MW15-01 pumping test was conducted from June 17 through June 19, 2015 with a total pumping duration of 49.9 hours and a constant pumping rate of 13.9 gpm. The pre-pumping depth to water was 59.22 feet and post-pumping level 120.44 feet for a total drawdown of 61.2 feet. Drawdown in pumping well MW15-01 occurred very rapidly with 50% of drawdown (31 feet) occurring in the first three minutes and 90% (55 feet) in the first 60 minutes of pumping. The rate of drawdown decreased significantly after 60 minutes to a near constant 0.08 ft/hour for the final 46 hours of pumping. Similarly, post-pumping water level recovery was very rapid with 90% recovery occurring within 55 minutes of pump shutdown and recovery rates slowing significantly after that. Full recovery was reached about 65 hours after the end of pumping.

Linear, log, and semi-log time-drawdown graphs from MW15-01 are shown in Figure 3-8. The log and semi-log plots do not follow a typical Theis type curve (see AQTESOLV curve matching graphs in Appendix C) suggesting non-radial flow to the well during pumping. This suggests that the bedrock groundwater system in the vicinity of MW15-01 does not act as an equivalent porous media (EPM) on the scale of the pumping test. Similarly, the time-drawdown graphs do not match well with type plots for a single vertical fracture or a discrete fracture zone (fractured dike) as presented in Kruseman and de Ridder (1994). The MW15-01 time-drawdown curves most closely approximate that of a double porosity system, with primary fractures controlling the main groundwater flow, and a secondary fracture system within the adjacent matrix blocks feeding the secondary fracture system. The drawdown plots also exhibit effects of well loss, wellbore storage and partial well penetration. A late time increase in drawdown after about 300 minutes of pumping, most apparent on the semi-log plot, may be the late time phase of flow to the well when water is derived from both the main fracture system and the matrix blocks, or could represent a low permeability boundary.

Wells MW12-16, MW15-03, and MW15-04 (Figure 3-2) were monitored as observations wells during the MW15-01 pumping test but no drawdown was recorded in any of these wells. The lack of drawdown at observations wells MW12-16 and 15-03, located 500 feet north of the pumping well, further indicates non-radial flow to the pumping well during the test. Based on the calculated bedrock hydraulic parameters, and drawdown recorded in the pumping well, a simple Theis analysis suggests that drawdown at a distance of 500 feet from the pumping well should have been on the order of 20

TABLE 3-6. CONSTANT DISCHARGE PUMPING TEST DETAILS AND RESULTS

Monitoring Sites		Screen Interval	Pumping Period	Pumping Duration	Distance from Pumping Well	Initial DTW	Draw down	Total Volume Pumped	Pumping Rate	Hydraulic Conductivity	
		feet		*hours*	*feet*	*feet*	*feet*	*gallons*	*gpm*	*feet/day*	*meters/sec*
Pumping Well	**MW 15-01**	**182-221**	**6/17/15-6/19/15**	**49.85**	**0**	**59.22**	**61.2**	**41,500**	**13.9**	**1.1**	**4.0E-06**
Observation Wells	MW 12-16	141-191	---	---	500 N	109.05	-0.07	---	---	---	---
	MW 15-03	345-385	---	---	500 N	109.70	-0.02	---	---	---	---
	MW 15-04	170-220	---	---	715 NE	62.63	-0.03	---	---	---	---
Pumping Well	**MW 15-02**	**147-197**	**6/23/15-6/26/15**	**74.15**	**0**	**68.88**	**48.6**	**97,000**	**21.8**	**0.2**	**8.5E-07**
Observation Wells	MW 12-16	141-191	---	---	350 S	109.04	-0.01	---	---	---	---
	MW 15-03	345-385	---	---	350 S	109.71	-0.09	---	---	---	---
Pumping Well	**MW 12-18**	**80-115**	**7/6/15-7/9/15**	**73.0**	**0**	**36.44**	**17.0**	**29,500**	**6.7**	**0.4**	**1.4E-06**
Observation Wells	MW 12-17	155-195	---	---	5	37.35	0.93	---	---	---	---
	MW 15-05	240-290	---	---	250 S	34.18	-0.11	---	---	---	---
	MW 15-06	350-400	---	---	250 S	39.95	-0.17	---	---	---	---

DTW - Depth to Water
Negative value indicates increase in water level.

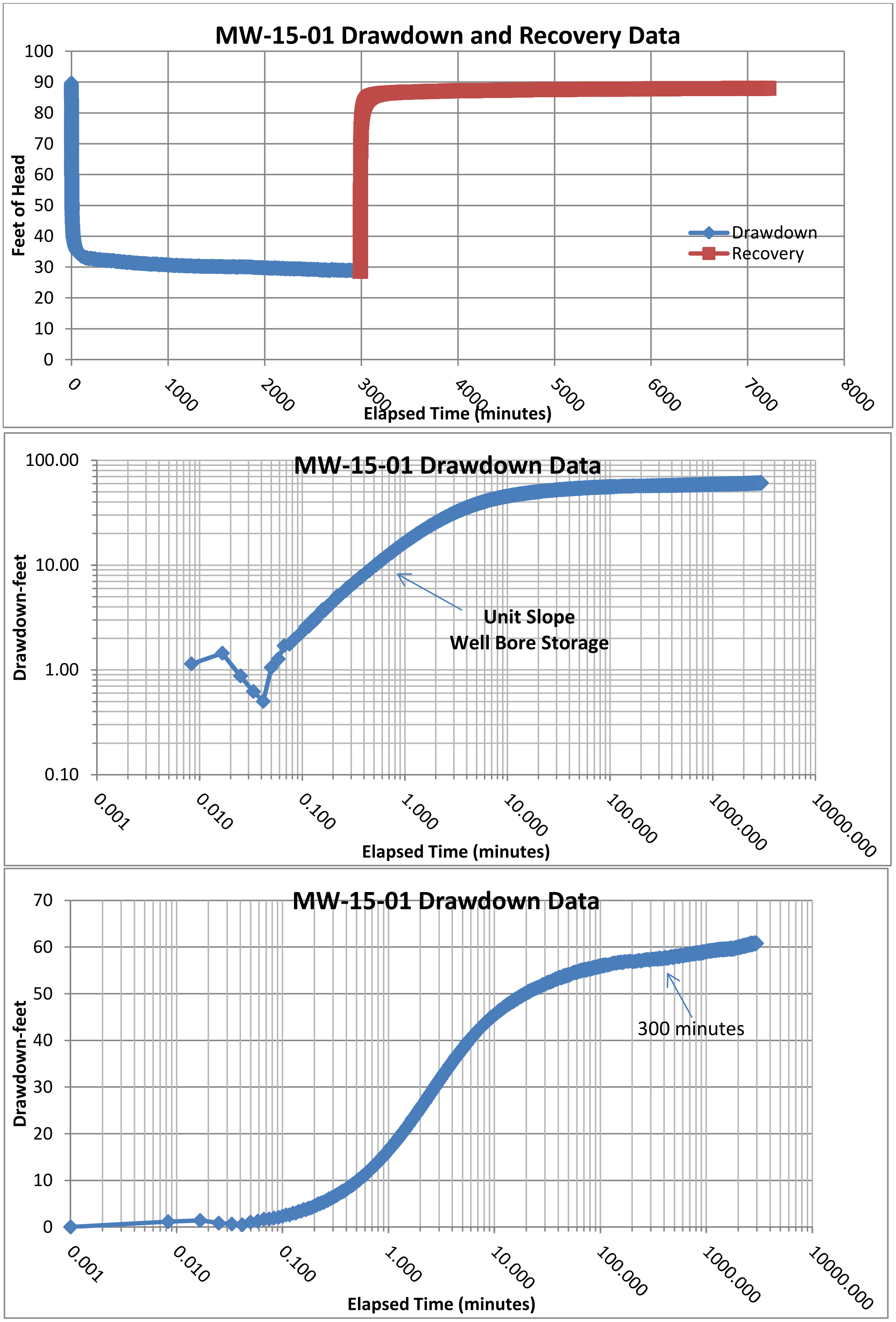


Figure 3-8. Time-Drawdown Curves for MW15-01 Constant Discharge Pumping Test

feet. The lack of drawdown to the north suggests an east-west orientation to the main flow-controlling fracture system and/or one or more low permeability boundaries between the pumping well and observation wells.

Both of these flow-controlling effects are consistent with other results of the West Ridge hydrogeologic evaluation as discussed in Section 4.2.

MW15-02 Pumping Test

MW15-02 is located in the central portion of the West Ridge approximately 350 feet north of the potentiometric low centered on well MW12-16 (Figure 3-2). Similar to MW15-01, groundwater levels at MW15-02 are notably higher than those at MW12-16 (approximately 6415 versus 6380 feet), further constraining the lateral (northern) extent of the potentiometric low.

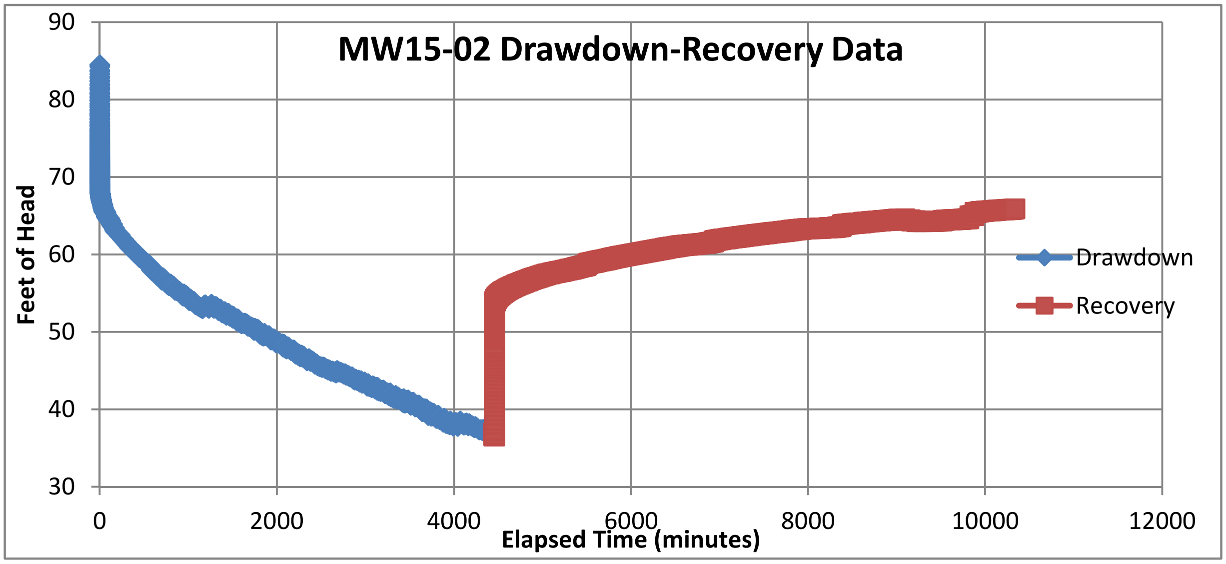
The MW15-02 pumping test was conducted from June 23 through June 26, 2015 with a total pumping duration of 74.2 hours and a constant pumping rate of 21.8 gpm. The pre-pumping depth to water was 68.9 feet, and the post-pumping water level was 117.5 feet for a total drawdown of 48.6 feet. At the start of pumping, water levels declined rapidly in the pumping well with 11 feet of drawdown (22% of total) in the first 1.7 minutes of pumping, after which the drawdown rate slowed but continued at a near steady rate for the remainder of the three day test. During the last two days of pumping, the rate of decline decreased from 0.35 feet/hour to 0.25 feet/hour at the end of the test, with no indications of equilibrium being approached. Post-pumping water level recovery was slow with the water level recovering to 60% of pre-pumping levels 98 hours after the end of pumping, and not reaching full recovery for several months after pumping.

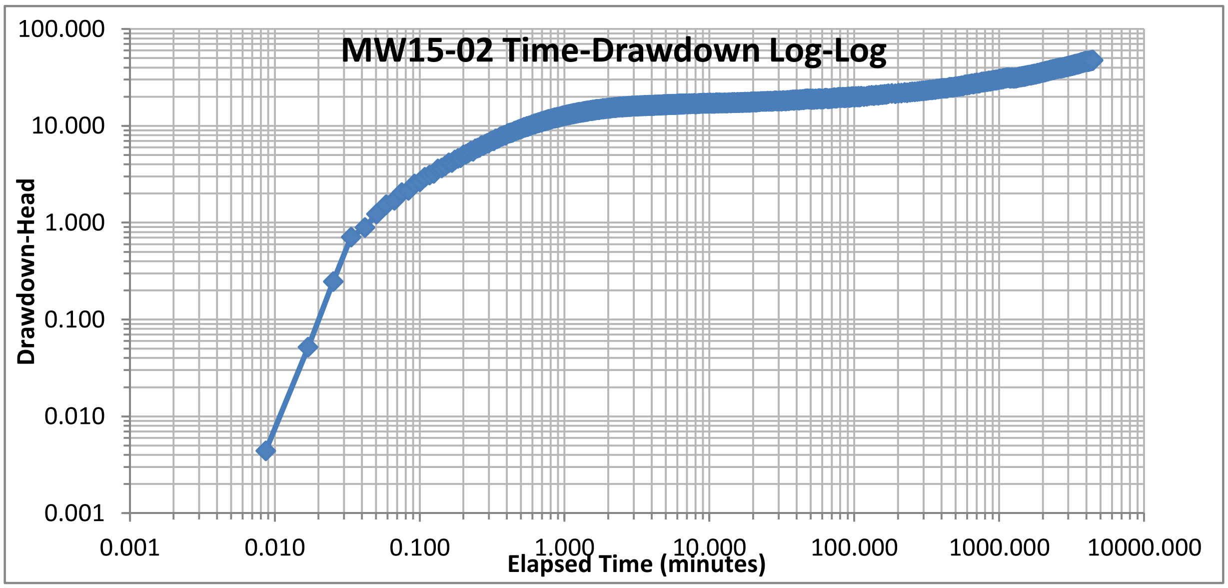
Linear, log, and semi-log time-drawdown graphs from MW15-02 are shown in Figure 3-9. Similar to MW15-01, log and semi-log plots best approximate trends expected for a double porosity fracture flow system, with well loss, borehole storage, and partial penetration effects apparent in the early time data. A number of potential boundary conditions are also apparent in the drawdown curve with a decrease in the rate of drawdown at 44 hours (i.e., dewatering of a fracture), and an increase in drawdown at 58 hours, potentially representing a low permeability boundary (Figure 3-10).

Wells MW12-16, MW15-03, and MW15-04 were also monitored as observation wells during the MW15-02 pumping test but no drawdown was recorded in any of the observation wells. Similar to the MW15-01 test, the lack of drawdown at these sites supports a model of asymmetric flow and the presence of an east-west orientation to the major flow axis and/or the presence of low permeability boundaries north and south of MW15-02. Based on the Theis solution for an EPM system with radial flow, expected drawdown would be about 30 feet at MW12-16 and MW15-03, located 250 feet south of MW15-02.

MW12-18 Pumping Test

MW12-18 is located in the northern portion of the West Ridge immediately south of Lineament 1 (Figure 3-2). MW12-18 was included in the 2015 pumping test program due to the relatively high hydraulic conductivity value obtained during a preliminary slug testing program (Section 3.5.1).





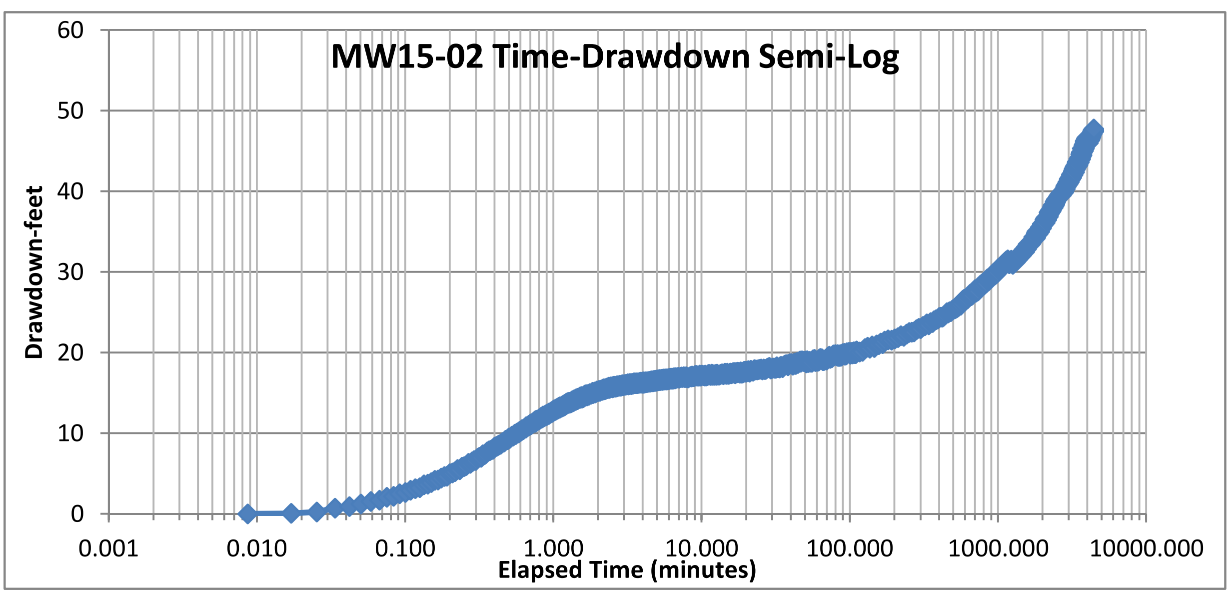


Figure 3-9. Time-Drawdown Curves for MW15-02 Constant Discharge Pumping Test

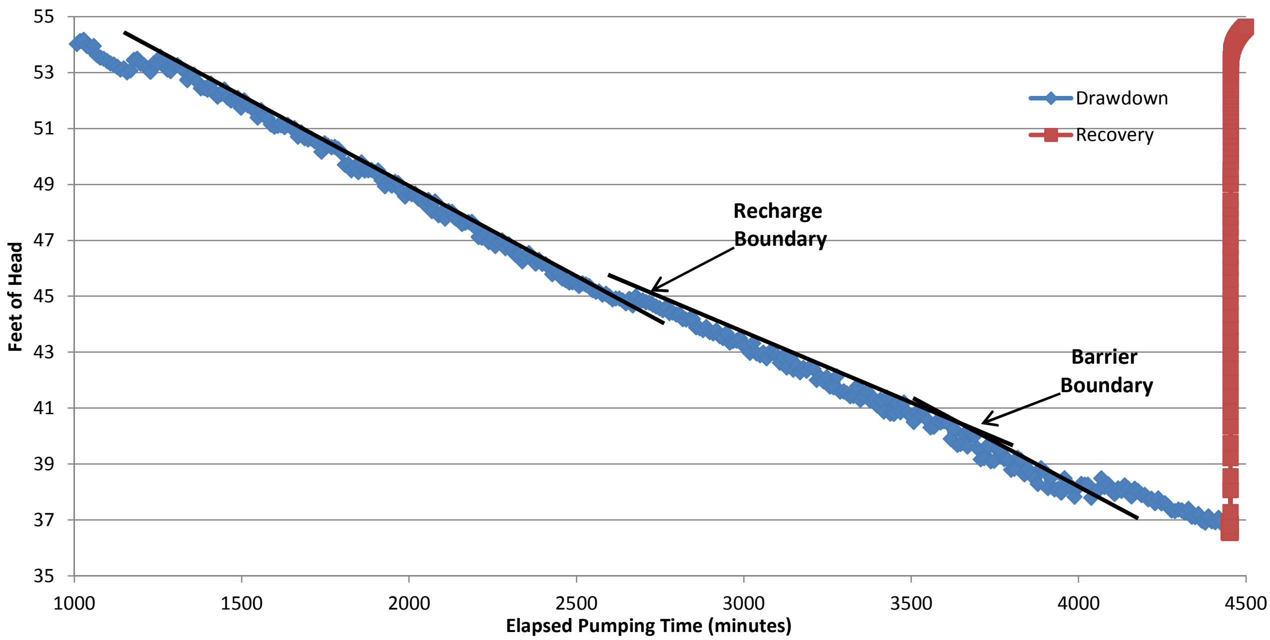


Figure 3-10. MW15-02 Drawdown Trends

The MW12-18 pumping test was conducted from July 6 through July 9, 2015 with a total pumping duration of 73 hours and a constant pumping rate of 6.7 gpm. The pre-pumping depth to water was 36.44 feet and post-pumping level 53.45 feet for a total drawdown of 17.0 feet.

The time-drawdown curve for MW12-18 (Figure 3-11) follows a similar trend to that at MW15-02 with water levels dropping rapidly at the start of pumping. The water level dropped approximately 6.5 feet, or 35% of total drawdown, in the first 30 seconds with apparent well loss and borehole storage effects superimposed on the early time data. Following the initial steep drawdown, the rate of decline decreased sharply with water levels declining about 0.33 feet/minute from 0.5 to 5 minutes, and 0.01 feet/minute the next 30 minutes. For the last 24 hours of pumping, water levels declined at a near steady 0.001 feet/minute or 0.06 feet/hour. Post-pumping water level recovery was slow with water levels recovering to 90% of pre-pumping levels on August 1st, 22 days after the end of pumping.

Wells MW15-05 and MW15-06 were also monitored as observation wells during the MW12-18 pumping test, but no drawdown was recorded in either observation well. Similar to the other constant discharge pumping tests, the lack of drawdown at these sites supports a model of secondary fracture dominated flow with the presence of an east-west orientation to the major flow axis and/or the presence of low permeability boundaries north and south of MW12-18.

3.5.2.1 Constant Discharge Pumping Test Data Analyses

Following correction for barometric pressure changes, the time-drawdown data from each pumping test was analyzed to calculate bedrock hydraulic properties using the AQTESOLV software package. Due to the lack of drawdown in all observation wells, data analysis was limited to the pumping well data from each test. Although background seasonal water level trends were documented at the time of each test, the background trends of a few hundredths of a foot per day were deemed insignificant compared to the pumping induced drawdown, and therefore correction for background trends was not applied.

Based on the diagnostic time-drawdown curves, each dataset was analyzed by three different solutions including the Moench double porosity with slab-shaped blocks (1984), Barker double porosity with slab-shaped blocks (1988), and Theis-Hantush. Moench and Barker assume a fractured isotropic aquifer with double porosity; a primary porosity associated with the parent matrix as well as a secondary porosity associated with fracturing. The Theis-Hantush solution assumes an EPM or homogeneous matrix. The current knowledge of the system suggests that the double porosity solutions best approximate the actual bedrock conditions and are more appropriate for the West Ridge bedrock system; however, Theis-Hantush analyses were performed for comparative purposes. All three solutions were applied to the pumping and recovery data for each of the pumping well datasets.

Calculated hydraulic conductivity values for the constant discharge pumping tests are shown in Table 3-7 and curve matching plots are included in Appendix C. For all three datasets, the double porosity solutions provided a better fit to the drawdown and recovery data than the Theis-Hantush solution.

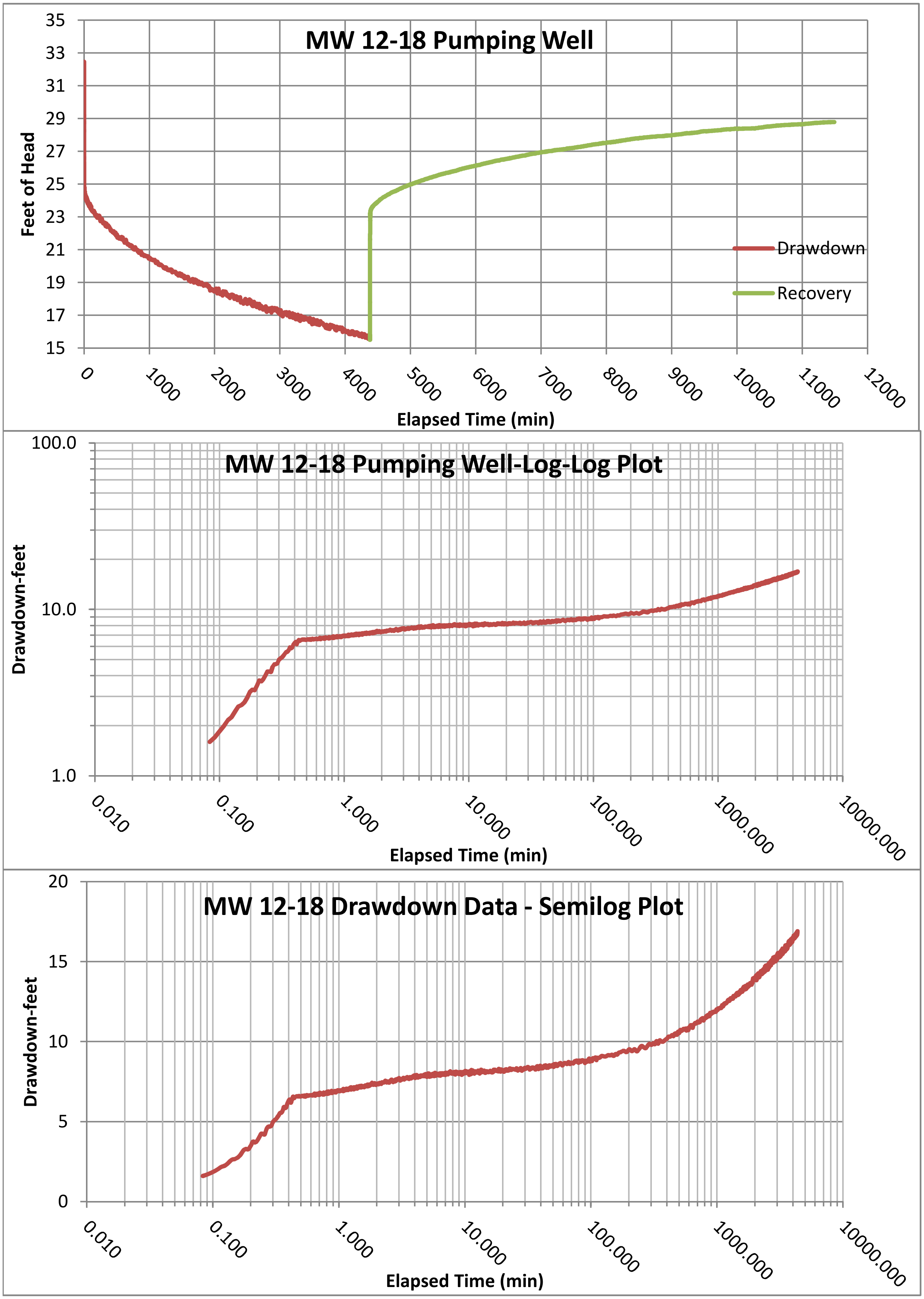


Figure 3-11. Time-Drawdown Curves for MW12-18 Constant Discharge Pumping Test

The resulting hydraulic conductivity values for MW15-02 and MW12-18 are similar (within an order of magnitude), with MW15-01 up to an order of magnitude higher. This is consistent with the much faster recharge rate recorded at MW15-01 compared to the other pumped wells. The constant discharge test results are also consistent with those obtained from other components of the West Ridge testing program.

TABLE 3-7. CONSTANT DISCHARGE PUMPING TEST HYDRAULIC CONDUCTIVITY RESULTS

	Barker Solution ft/day	Moench Solution ft/day	Theis/Hantush ft/day
MW-15-01	1.21	0.84	1.39
MW-15-02	0.08	0.03	0.31
MW-12-18	0.10	0.20	0.86

3.5.3 Long-Term Pumping Test on Deep Isolated Fracture System

As part of the overall YDTI West Ridge hydrologic evaluation, Hydrometrics also conducted a long-term pumping test in 2016 on monitoring well MW16-02D, completed in the deep isolated fracture system. The pumping test objectives, in order of priority include:

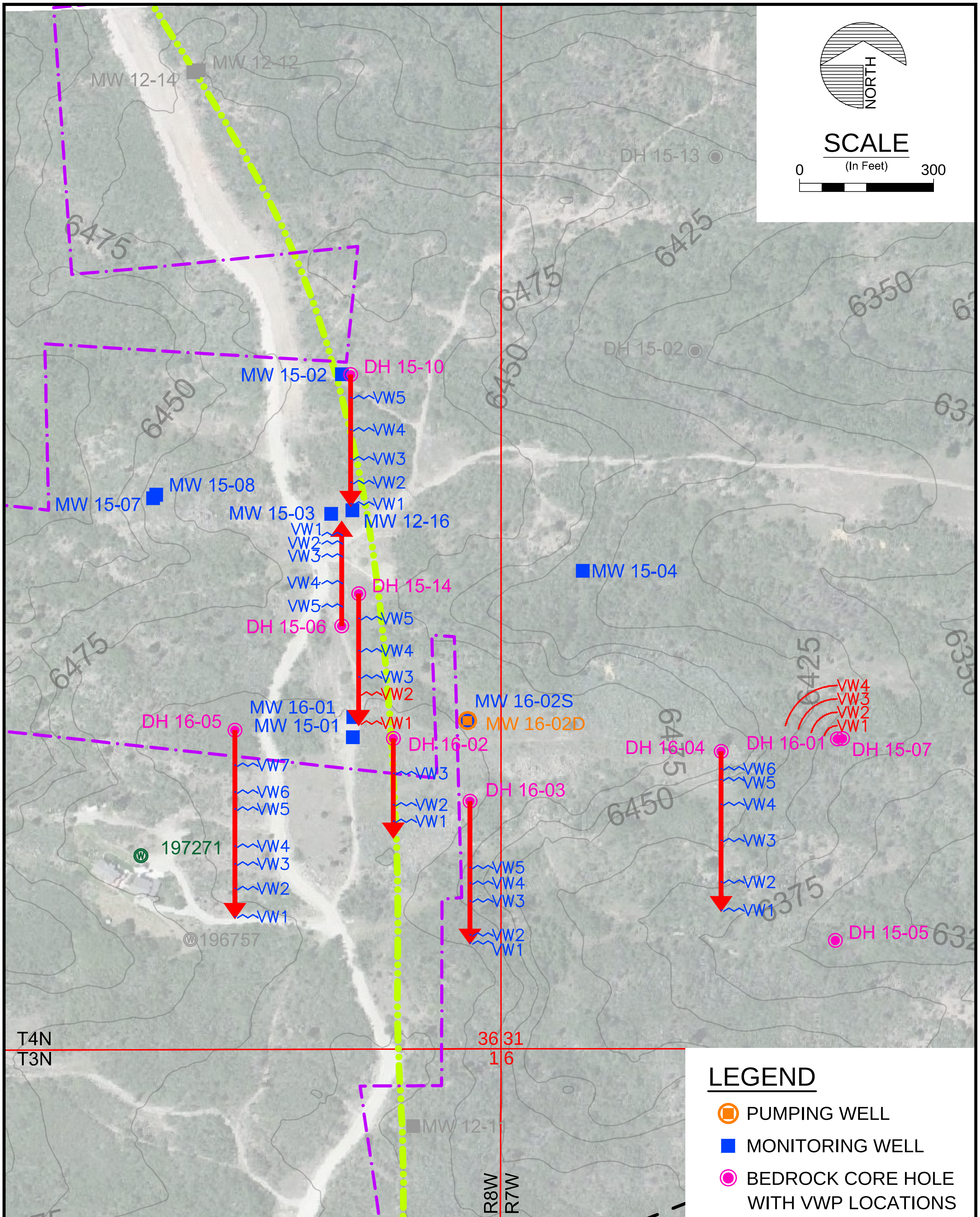
1. Lower water levels within the deep isolated fracture system to the extent possible and monitoring the response in surrounding wells and VWPs to identify potential boundaries of the fracture system and overall bedrock interconnectivity.

2. Evaluate the bedrock fracture system hydraulic properties (hydraulic conductivity, storativity) to the extent possible from the test.

Information obtained through the pumping test was used to evaluate potential connections between the deep isolated fracture system and the YDTI, and if the fracture system could act as a pathway for westward seepage from the impoundment under future expanded conditions.

3.5.3.1 Aquifer Testing Procedures

The West Ridge deep isolated fracture system aquifer test was a 14-day variable rate pumping test with pumping starting on August 17th and ending August 31st. Monitoring well MW16-02D served as the pumping well with surrounding monitoring wells and drillhole VWPs serving as observation points. The pumping rate varied from 12.5 gpm at the start of the test to 6.6 gpm at the end of the test and averaged 8.3 gpm over the 14-day pumping period. The decrease in pumping rate was due to both the declining water level in the pumping well during the test, and intentional adjustments made to the pumping rate to maintain the water level above the pump. With the pump set in the well at 440 feet bgs, the flow rate was periodically adjusted (reduced) to maintain the water level above the pump so that the test could be conducted for an extended period of time. The monitoring network is shown on Figure 3-12 and test details are in Table 3-8.



LEGEND

PUMPING WELL

MONITORING WELL

BEDROCK CORE HOLE WITH VWP LOCATIONS

HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA	**LONG-TERM PUMPING TEST MONITORING NETWORK**	FIGURE **3-12**

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TABLE 3-8. LONG-TERM PUMPING TEST MONITORING NETWORK AND DETAILS
YDTI WEST RIDGE HYDROLOGIC EVALUATION

Monitoring Sites				Location from Pumping Well	Depth/Elevation (feet)	Recording Interval
Pumping Well	MW16-02D	Deep Fracture System Monitoring Well		Mid West Ridge near crest	489-549/5949-6009	0.5 seconds to 1 minute
Observation Points	MW16-01	Deep Fracture System Monitoring Well		255 feet West	485-517/5983-6015	1 minute
	MW15-01	Bedrock Groundwater System Monitoring Well		270 feet W-NW	182-222/6280-6320	15 minutes
	MW16-02S	Bedrock Groundwater System Monitoring Well		0' - paired with pumping well	244-264/6234-6254	15 minutes
	DH15-06	Angled core hole with 5 vibrating wire piezometers	Upper VWP (VWP5)	375' NW	130/6368	15 minutes
			Lower VWP (VWP1)	510' NNW	685/5872	
	DH15-10	Angled core hole with 5 vibrating wire piezometers	Upper VWP (VWP5)	775' NNW	120/6374	15 minutes
			Lower VWP (VWP1)	550' NNW	685/5866	
	DH15-14	Angled core hole with 5 vibrating wire piezometers	Upper VWP (VWP5)	330' NW	115/6368	15 minutes
			Lower VWP (VWP1)	240' West	611/5872	
	DH16-01	Vertical core hole with 4 vibrating wire piezometers	Upper VWP (VWP4)	825' East	203/6191	15 minutes
			Lower VWP (VWP1)	825' East	374/6020	
	DH16-02	Angled core hole with 3 vibrating wire piezometers	Upper VWP (VWP3)	195'SW	185/6326	15 minutes
			Lower VWP (VWP1)	300'SSW	438/6084	
	DH16-03	Angled core hole with 5 vibrating wire piezometers	Upper VWP (VWP5)	330' South	350/6177	15 minutes
			Lower VWP (VWP1)	500' South	751/5799	
	DH16-04	Angled core hole with 6 vibrating wire piezometers	Upper VWP (VWP6)	600' East	100/6376	15 minutes
			Lower VWP (VWP1)	720' SE	840/5674	
	DH16-05	Angled core hole with 7 vibrating wire piezometers	Upper VWP (VWP7)	525'WSW	185/6339	15 minutes
			Lower VWP (VWP1)	765'SW	987/5621	
	Daily Inactive	Residential well (inactive)		800'SW	320-360/6180-6140	60 minutes
	Varnavus Barn	Residential well (active)		2700' West	160-175/6148-6133	15 minutes
	Varnavus Field	Residential well (inactive)		2500' West	260-300/6043-6083	15 minutes
Pumping Rate	12.5 to 6.6 gpm; average 8.1 gpm					30 seconds
Pumping Duration	337.67 hours (14.07 days)					

Elevations relative to ACC Datum.
Monitoring locations shown on Figure 3-12.

Water levels (or piezometric heads) were recorded automatically during the test using the VWPs in the drillholes, and transducers/dataloggers in monitoring wells. For the pumping well, the water level was recorded on the following schedule to capture early time drawdown data:

Pumping Time	Recording Interval
0 to 10 minutes	0.5 seconds
10 to 60 minutes	1.0 second
1 to 8 hours	10 seconds
Remainder of test	1 minute

At observation well MW16-01, completed in the deep isolated fracture system, a constant recording interval of 1 minute was used for the entire pumping period. At wells MW15-01 and MW16-02S, and all core hole VWPs, a constant 15 minute recording interval was used.

Pumping rates were measured with a Seametrics flowmeter and datalogger. Flow measurements were recorded every 30 seconds on the datalogger with manual readings recorded multiple times each day during the pumping period. A mechanical flowmeter capable of instantaneous and total flow readings was installed in series with the electronic flow meter for backup.

The discharge water was initially piped and discharged approximately 300 feet east and downhill of the pumping well to allow the discharge water to drain towards the YDTI. After the first few days of pumping, the water level in monitoring well MW15-04 began to increase, apparently due to infiltration of the pump discharge water. Additional discharge line was added to convey the discharge water all the way down to the YDTI west embankment, shortly after which the water level in MW15-04 began to decline. Well MW15-04 is completed in the main bedrock groundwater system (screened 170 to 220 feet bgs), outside of the deep isolated fracture system being pumped. Therefore, the temporary infiltration of discharge water to this well is not believed to have affected the deep isolated fracture system response to pumping. Note that the MW15-04 response to the short-term surface discharge of approximately 6 gpm illustrates the sensitivity of the bedrock groundwater system to small variations in recharge.

3.5.3.2 Aquifer Testing Results

As noted above, the primary objective of the long-term test was to identify the lateral and vertical extent of the deep isolated fracture system, including areas of hydraulic connectivity to and potential boundaries of the fracture system. This was achieved by observing locations throughout the monitoring network that responded to the long-term pumping. Water level responses at observation points during the long-term test fall into four categories:

- Wells/VWPs with a rapid and direct response to pumping, indicating a direct hydraulic connection to the pumping well;

- Wells/VWPs with a delayed and muted response, most likely indicating slow leakage to the primary fracture(s) being pumped from smaller secondary fractures and/or through low permeability structures;

- Wells/VWPs exhibiting no response to pumping; and
- Wells/VWPs exhibiting a reverse response or increase in water levels.

Water level responses at various locations are listed in Table 3-9 and shown on Figure 3-13. Additional information from the pumping test is included in Appendix C.

Direct responses to the MW16-02D pumping occurred at monitoring well MW16-01, VWP1, and VWP2 in angle drillhole DH15-14, and at VWP 1, 2, and 3 in vertical drillhole DH16-01. These sites all lie along an east-west line with MW16-02D, coincident with the main West Ridge structural trend. Besides the pumping well with a total drawdown of 261 feet, the greatest responses occurred at MW16-01 and DH15-14 VWP2, where water levels decreased 169 and 166 feet, respectively. Both of these observations points are located about 250 feet west of the pumping well and are completed at a similar depth and elevation as the pumping well. VWP1 in DH15-14, located about 60 feet deeper than the pumping well, had 140 feet of total drawdown during the pumping test (Table 3-9). Drawdown in VWP1, 2, and 3 in DH16-01, located approximately 850 feet east of the pumping well, ranged from 6.0 to 3.0 feet.

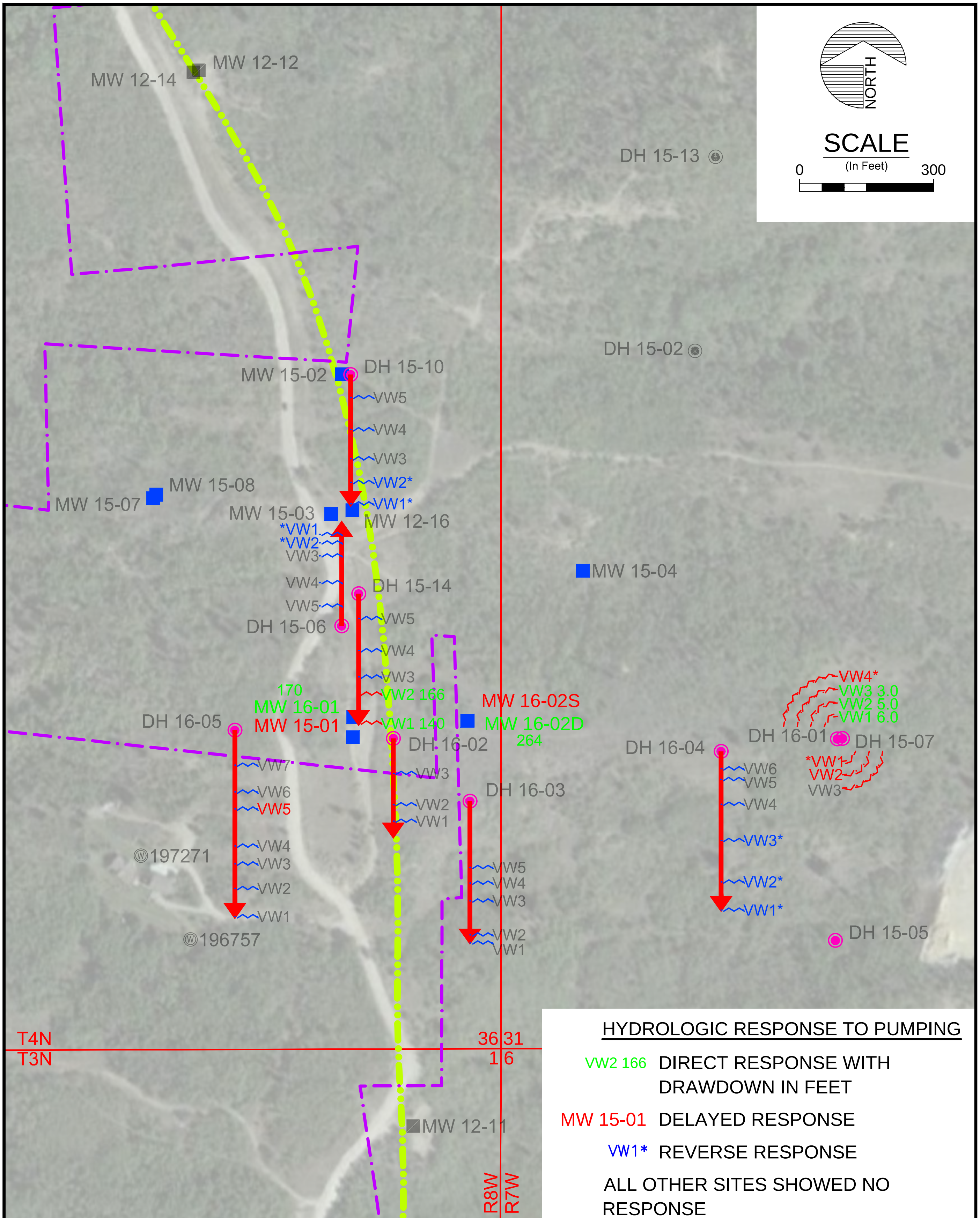
Delayed responses were noted at a number of sites including monitoring wells MW15-01 and MW16-02S, located near the pumping well but at shallower depths, and at VWP1 and 2 in DH15-07 and VWP4 in DH16-01, located east of the pumping well. Delayed drawdown at these sites is on the order of 1 to 2 feet with the time to initial drawdown ranging from 15 to 72 hours after the start of pumping (Table 3-9). DH16-05 VWP5, located west of the pumping well (and west of Moulton Reservoir Road, Figure 3-11), also exhibited an apparent delayed yield response to pumping although the response was greater (≈5 feet) and delay longer (13.5 days) than the delayed yield responses at other sites.

The delayed yield response is believed to represent leakage to the deep isolated fracture system from portions of the bedrock groundwater system external to the deep fracture system. The delayed yield also indicates some level of hydraulic communication between the deep isolated fracture system and surrounding bedrock, indicating the potential for recharge to the fracture system from the surrounding, higher piezometric head bedrock.

A number of VWPs exhibited a reverse response (i.e., temporary increase in head) to pumping of the deep isolated fracture system. Reverse responses to pumping are attributable to poroelastic effects, where redistribution of effective stresses within bedrock due to pumping from a confined groundwater system results in an increase in pore pressures outside of the confined system (Burbey, 2013). Thus, a reverse response at an observation point indicates the presence of a low permeability zone between that point and the pumping well.

TABLE 3-9. WATER LEVEL RESPONSES TO LONG-TERM PUMPING TEST
YDTI WEST RIDGE HYDROLOGIC EVALUATION

SITE		Total Drawdown (feet)	Time to Initial Response	Comments
MW16-02D	---	264	0 minutes	Pumping Well
MW16-01	---	169.3	7 minutes	Direct response
MW15-01	---	≈1.0	15 hours	Delayed response
MW16-02S	---	≈1.0	27 hours	Delayed response; possible reverse response
DH15-06		0	na	Reverse response at VW1 and VW2
DH15-10		0	na	Reverse response at VW1 and VW2
DH15-14	VW1	140	<15 minutes	Direct response
	VW2	166	<15 minutes	Direct response
	VW3	0	na	No response
	VW4	0	na	No response
	VW5	0	na	No response
DH15-07	VW1	2	32 hours	Delayed response; and reverse response
	VW2	1	72 hours	Delayed response
	VW3	0	na	No response
DH16-01	VW1	≈6	na	Direct response; timing unclear due to background trends.
	VW2	≈5	na	Direct response; timing unclear due to background trends.
	VW3	≈3	na	Direct response; timing unclear due to background trends.
	VW4	≈2.5	na	Delayed response; and reverse response
DH16-02		0	na	No response
DH16-03		0	na	Possible reverse response at VW1 and VW2
DH16-04		0	na	Reverse response at VW1, VW2, and VW3
DH16-05	VW1	0	na	No response
	VW2	0	na	No response
	VW3	0	na	No response
	VW4	0	na	No response
	VW5	≈5	13 days	Possible delayed response
	VW6	0	na	No response
	VW7	0	na	No response



HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA

LONG-TERM PUMPING TEST WATER LEVEL RESPONSES

FIGURE

3-13

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Sites exhibiting a reverse response include DH15-06 VWP1 and VWP2; DH15-10 VWP1 and VWP2; DH15-07 VWP1; DH16-01 VWP4; and DH16-04 VWP1, VWP2, and VWP3 (Table 3-9). As shown on Figure 3-13, these sites are located to the north, east, and south of pumping well MW16-02D. The head increases generally begin immediately after the start of pumping and last from a few hours to several days, with the magnitude of increases ranging from 0.5 to 2.0 feet. The magnitude and duration of these increases is greater than generally reported for poroelastic effects, suggesting that bedrock settlement may have been greater than typically occurs from pumping.

In summary, the monitoring well and VWP responses to the deep fracture system long term pumping test show a distinct east-west trend of sites exhibiting a direct response to pumping, with water level drawdown on the order of 200 feet at the ridge crest (near the pumping well), and decreasing rapidly to a few feet at DH16-01 located 850 feet east of the pumping well. Delayed drawdown responses were noted relatively short distances north, south and west of the pumping well, indicating the presence of low permeability boundaries restricting groundwater flow in these directions. Delayed yields observed in monitoring wells completed above the fracture system (completion depths 200 to 300 feet), indicate an upper bounding structure as well. Observed reverse water level responses further indicate the presence of low permeability structures bounding the low head fracture system to the north, south and west. This information is consistent with the drilling information and geologic models developed for the area (Section 4.2), and addresses the primary objective of the long-term pumping test.

3.5.3.3 Long-Term Pumping Test Data Analysis

Figure 3-14 includes time-drawdown plots for pumping test observation well MW16-01. Interpretation of the log and semi-log plots is complicated by the fracture system geometry and variable pumping rate, although the log-log and semi-log plots most closely resemble diagnostic plots for a linear, bounded zone of higher permeability bedrock within lower permeability country rock (similar to the permeable dike model in Kruseman and de Ridder, 1994). Based on this model, and the highly fractured nature of the bedrock core recovered from the deep isolated fracture system, the long-term pumping test data was analyzed as a bounded, highly fractured equivalent porous media.

Aquifer test data analysis was performed using the AQTESOLV software package and time-drawdown data from monitoring well MW16-01, and VWP 1 and VWP 2 from drillhole DH15-14, all sites where direct responses to pumping were observed. Although a direct response was also observed at drillhole DH16-01, background trends at that site apparently caused by nearby construction dewatering, preclude detailed analysis of that data. Likewise, analyses were not performed on pumping well MW16-02D due to effects of well loss and the availability of reliable observation well data. The data analysis included the drawdown data from the 14-day pumping period. The water level recovery data was not analyzed due to the delayed recovery response. After pumping ended, water levels at the observations wells continued to decline for two to three days (Figure 3-14) interfering with the recovery data analysis. Although a slight declining trend in background water levels was recorded during the testing period, the rate of decline, 0.005 feet/hour, was considered insignificant compared to the 100+ feet of drawdown recorded at the observation points, so background trend corrections were deemed unnecessary.

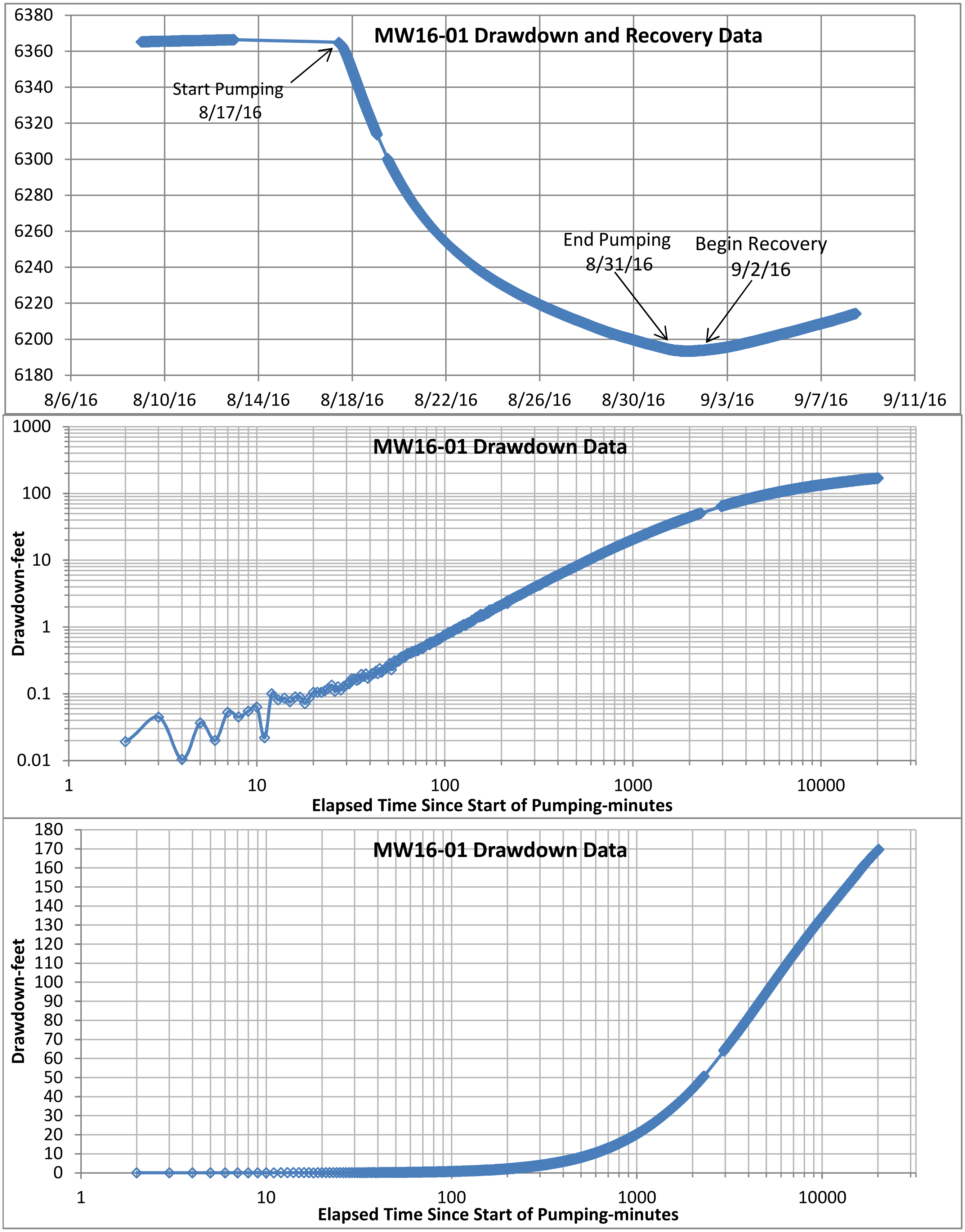

Figure 3-14. Time Drawdown Curves for Observation Well MW16-01 from Deep Fracture System Long-Term Pumping Test

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Low permeability fracture system boundaries inferred both from the distribution of observed drawdown and from geological information obtained from the site were simulated using the boundary package in AQTESOLV. Vertical no flow boundaries were included in the analyses with the boundaries located 350 feet to the north, 350 feet south, and 350 west of the pumping well. AQTESOLV simulates the three no-flow boundaries through use of image wells. Based on lithologic information from drillhole DH15-14 and DH16-01, a saturated thickness of 100 feet was applied for the main water-bearing fracture system. For the VWPs, a well diameter of 0.01 foot and screen length of 1.0 feet was used in the analyses.

The pump test data were evaluated using the Theis solution for confined aquifers, with the variable pumping rate and partial well penetration taken into account. Analytical results for the three observation points are summarized in Table 3-10 with curve matching plots included in Appendix C. Resulting hydraulic conductivity values for observation well MW16-01 and DH15-14/VWP-2, both completed in the same depth interval as the pumping well, are 1.2 and 1.5 ft/day ($4.1*10^{-6}$ and $5.3*10^{-6}$ m/sec), respectively. These values are similar to that obtained from the MW15-01 single well pumping test (1.1 ft/day) and approximately an order of magnitude higher than MW15-02 and MW12-18 single well tests (0.2 and 0.4 ft/day, Section 3.5.2). The hydraulic conductivity obtained from DH15-14/VWP1, completed approximately 125 feet deeper than the pumping well and other observation points, is 0.4 ft/day ($1.4*10^{-6}$ m/sec). Storativity values obtained from the pumping test range from 1.6E-5 to 8.0E-4.

TABLE 3-10. LONG-TERM PUMPING TEST ANALYTICAL RESULTS

Monitoring Point	Depth feet bgs	Hydraulic Conductivity		Storativity
		feet/day	meters/sec	
MW16-01	485-517	1.2	4.1E-6	8.0E-4
DH15-14 VWP2	471	1.5	5.3E-6	1.7E-5
DH15-14 VWP1	611	0.4	1.4E-6	3.4E-5

Results of the long-term pumping test indicate that the bedrock hydraulic conductivity in the deep isolated fracture system near the West Ridge crest is up to an order of magnitude higher than the surrounding West Ridge bedrock groundwater system with conductivities highest in the 450 to 550 feet depth interval (elevation 6050 to 5950). Although hydraulically connected, the bedrock hydraulic conductivity decreases with depth below this interval. This decreasing hydraulic conductivity with depth is consistent with the decrease in fracturing noted in the DH15-14 core between VWP2 and the deeper VWP1 (as discussed further in Section 4.4.2). It should be noted that analysis of the long-term pumping test data is complicated by the complex and variable fracture characteristics observed in the bedrock core and the multiple boundary conditions present. Despite these limitations, and the fact that determination of the deep isolated fracture system hydraulic properties was not a primary objective of the long-term pumping test, the resulting fracture system boundaries are consistent with observed bedrock core characteristics and the lower hydraulic heads within the fracture system (indicating increased drainage) as compared to the surrounding West Ridge bedrock groundwater system.

3.5.4 Diamond Drillhole Packer Testing

KP conducted packer testing in the bedrock diamond drillholes to further characterize bedrock hydraulic properties and potential variability with depth. One hundred and thirteen falling head and constant head packer tests were completed within the West Embankment and West Ridge as part of the 2015 and 2016 site investigations. The packer tests were conducted at 20 to 60 foot downhole intervals. Five packer tests were conducted above the water table, five tests were conducted as open hole tests and 103 tests were successfully conducted in sealed test intervals below the water table.

The packer test (and other aquifer testing) results are summarized in Table 3-11 with results segregated by lithologic unit. A total of 104 tests were conducted on relatively unaltered BQM bedrock with a geometric mean hydraulic conductivity of 0.1 ft/day (3*10-7 m/sec). Higher hydraulic conductivity estimates are generally associated with test intervals that were characterized as highly to moderately fractured rock. Twelve of the packer tests were conducted on intervals including highly altered shear zones, with a geometric mean hydraulic conductivity of 0.01 ft/day ($3*10^{-8}$ m/sec). In all of these tests, the test interval included both shear zones and surrounding competent bedrock, suggesting that the hydraulic conductivity of the shear zones alone may be lower than that obtained from the 12 tests. Additional information on the packer testing procedures and results is provided in KP, 2017a.

TABLE 3-11. HYDRAULIC CONDUCTIVITY ESTIMATES BY LITHOLOGY

Lithology	Number of Tests	Minimum ft/day(m/sec)	Maximum ft/day(m/sec)	Geometric Mean ft/day(m/sec)
Quartz Monzonite	104	<0.003 (<1E-08)	1.7 (6E-06)	0.1 (3E-07)
Shear Zone/Dike	12	<0.003 (<1E-08)	0.04 (1E-07)	0.01 (3E-08)
Total Tests	116	<0.003 (<1E-08)	1.7 (6E-06)	0.06 (2E-07)

NOTES:

1. Minimum, maximum, and geometric mean hydraulic conductivity values are summarized for packer test results from the Phase 2A, 2B, 2C, and 5 site investigation programs as well as response test and constant discharge testing in monitoring wells (KP, 2017a).
2. Results of tests conducted above the water table or as open hole tests are not included in the summary statistics.
3. Test lithology is categorized as shear zone if at least half of the test interval is comprised of shear zone material and altered bedrock.

3.5.5 Aquifer Testing Summary

The West Ridge aquifer testing program included slug testing on seven wells, multi-day constant discharge pumping tests on three wells, a 14-day variable discharge pumping test on the deep isolated fracture zone, and a total of 113 packer tests at depths up to about 500 feet. Test results show the deep isolated fracture system to be the highest permeability unit along the West Ridge, the highly altered shears the lowest, and the bulk BQM bedrock to be intermediate to these two units. The hydraulic conductivity in the more permeable interval of the deep isolated fracture system is about an order of magnitude higher than the bulk bedrock throughout the West Ridge, which in turn is at least an order of magnitude higher than the highly altered shear zones. With the exception of the constant discharge pumping test on monitoring well MW15-01, recovery after all pumping tests was slow indicating recharge rates, and bedrock interconnectivity are limited. The distribution and type of water level responses to the long-term fracture system pumping test indicate that the deep isolated fracture system is bounded to the north, south, and west by low permeability structures, as well as an overlying confining unit. The information gained from the aquifer testing program was used to develop the conceptual models and technical analyses presented in the following sections.

4.0 WEST RIDGE HYDROLOGIC EVALUATION RESULTS

As described above, considerable information has been collected since 2012 regarding the West Ridge area hydrology. Diagnostic time-drawdown curves from the pumping tests, along with the distribution of water level responses and lithologic information suggest the West Ridge bedrock groundwater system is semi-confined while the deep fracture system is confined. The information and data collected through the hydrologic evaluation has been used to develop a conceptual model of groundwater conditions within the West Ridge, and to assess the potential for uncontrolled seepage from the YDTI through the West Ridge under the modified YDTI conditions (maximum operating pond level of approximately 6429 feet ACC). The following sections describe the West Ridge bedrock groundwater system conceptual model and flow regime under current and anticipated future conditions.

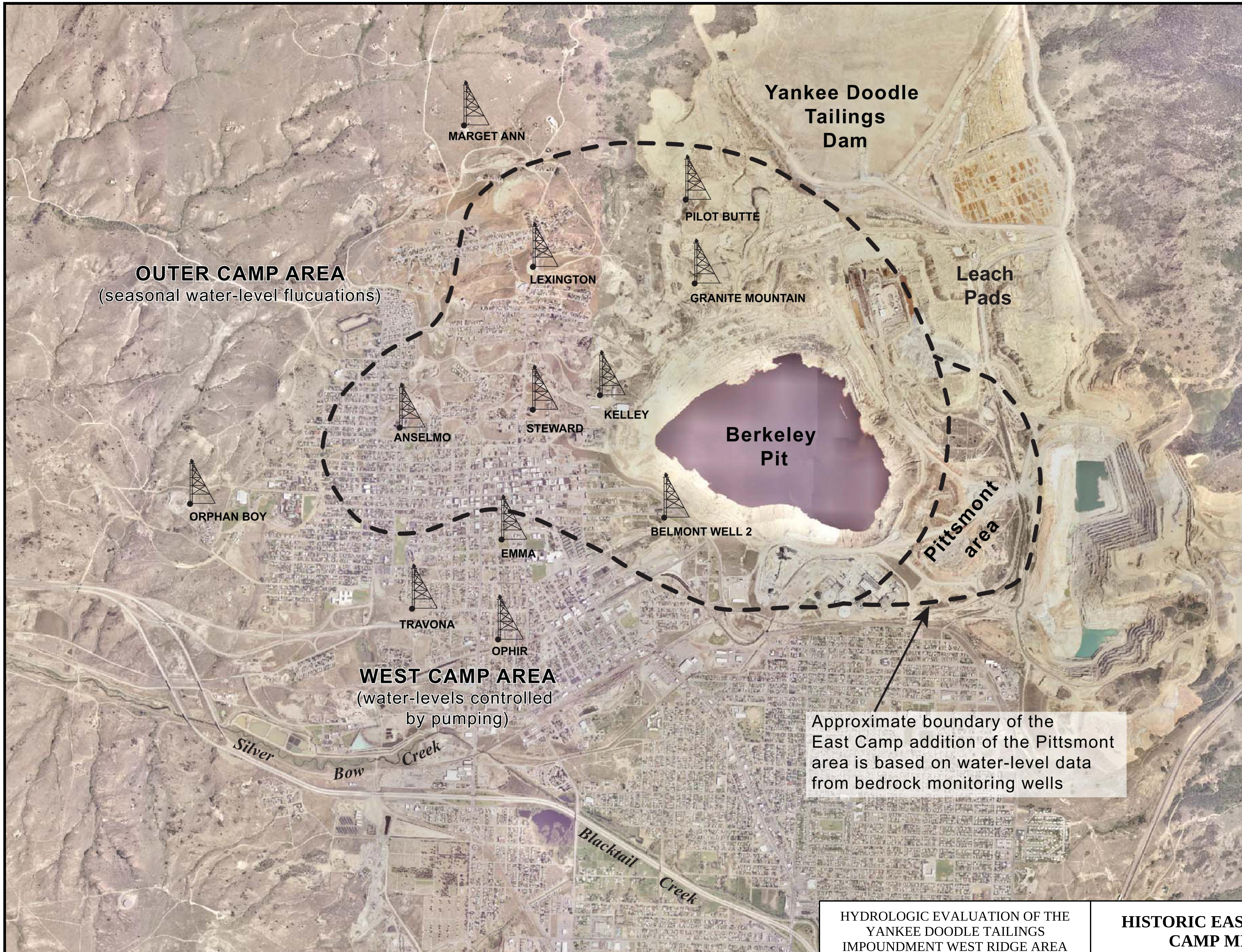
4.1 REGIONAL HYDROLOGIC SETTING

Groundwater conditions within the Butte area are strongly influenced by drainage and flow through the extensive historic mine workings in the area. Mine workings within the Butte Mine Flooding Operable Unit (BMFOU), one of the operable units designated under the Federal CERCLA program, are delineated as the East Camp, West Camp, and Outer Camp mine workings (Figure 4-1). The East Camp underground mine workings are connected and drain to the Berkeley Pit, a significant regional groundwater sink. Water levels in the East Camp workings are significantly lower than pre-historic mining water levels due to the slow refilling of Berkeley Pit since open pit mining and pit dewatering ceased in 1982. Water levels within the Berkeley Pit are currently about elevation 5335 feet (5393 ACC) and increasing at approximately 7 feet/year. The East Camp workings extend northward to within less than one mile of the West Ridge with the Pilot Butte Shaft being the northern-most water level monitoring point in the East Camp (Figure 4-1).

The West Camp mine workings historically were connected to the East Camp workings but were isolated from the East Camp through construction of bulkheads to reduce groundwater inflow and dewatering requirements during historic mining. Access points to the West Camp include the EMMA, Travona, and Ophir mine shafts (Figure 4-1). Water levels within the West Camp workings are maintained at about 5420 feet (5478 ACC) through pumping to maintain levels below the critical level of 5435 feet (5493 ACC) established by the CERCLA program to prevent outflow from the workings to surrounding groundwater. Thus, water levels within the West Camp remain below pre-mining levels.

The Outer Camp mine workings include a number of individual isolated historic mines with no current or historic connection to the East or West Camp workings. Outer Camp workings and monitoring access points closest to the West Ridge include the Marget Ann mine shaft (Figure 4-1) and nearby BMFOU monitoring well BMFOUS-4. Water levels in the Outer Camp workings are not affected by drainage or pumping from the other Camps and are reported to be at pre-historic mining levels (MBMG, 2016).

Butte Mine Flooding



Legend

Mines

0 1,000 2,000 3,000 Feet

SOURCE OF FIGURE: MBMG

HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA	HISTORIC EAST, WEST AND OUTER CAMP MINE WORKINGS	FIGURE 4-1

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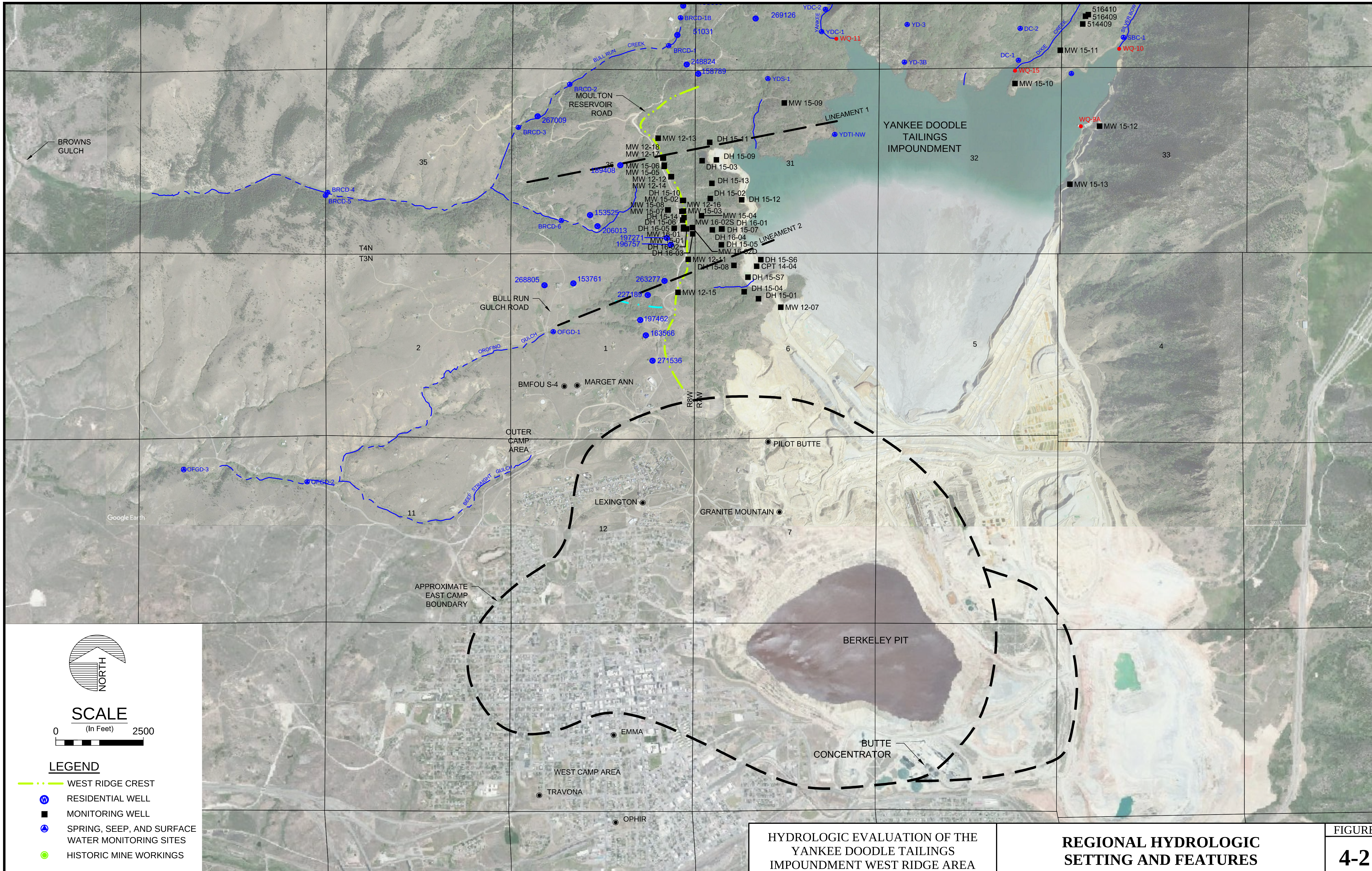
In order to assess the West Ridge bedrock groundwater system within the regional setting, and possible influences of the historic mine workings and depressed groundwater levels, groundwater conditions within the West Ridge were compared to those in the historic workings to the south. Figure 4-2 shows the locations of the East Camp, West Camp, and Marget Ann/BMFOUS-4 Outer Camp sites in relation to the West Ridge. As shown on the figure, the East Camp workings extend to within less than a half mile of the West Ridge monitoring and residential well network. Despite this relatively short distance, groundwater elevations in the West Ridge are more than 1,000 feet higher than those in the northern portion of the East Camp. For example, the groundwater elevation in West Ridge monitoring well MW12-15 was 6483 feet ACC in October 2016, while the corresponding water level in the East Camp Pilot Butte Shaft was 5418 feet ACC. This significant difference in groundwater elevations indicates minimal hydraulic connection and low hydraulic conductivity between the West Ridge bedrock groundwater system and the East Camp workings.

This lack of connection is also indicated through comparison of groundwater level trends in the West Ridge as compared to the East Camp workings. Figure 4-3 includes hydrographs from monitoring wells MW12-15 and MW12-11, located in the southern portion of the ridge, to water level hydrographs from the various historic mine workings. As shown in Figure 4-3a, water level trends within the East Camp workings exhibit a steady increase over the past several years due to the ongoing flooding of the underground workings and connected Berkeley Pit, while groundwater levels in the West Ridge do not follow this trend. Likewise, Figure 4-3b shows a lack of correlation between the pumping-controlled water levels in the West Camp workings with the West Ridge groundwater levels (the increase in the West Camp water level in 2013 was due to a temporary shutdown of the dewatering pumps). Conversely, Figure 4-3c shows that the West Ridge groundwater levels correlate well with those in the Marget Ann Shaft and BMFOUS-4 monitoring well of the Outer Camp. As noted above, the Outer Camp water levels are currently at pre-mining levels and not believed to be influenced by the drainage, refilling and pumping from the East and West Camp. By association, this suggests that groundwater levels and trends in the West Ridge bedrock groundwater system also are not influenced by hydrologic conditions in the historic workings encroaching to within 0.5 miles of the ridge. The significant difference in groundwater elevations over a relatively short distance (more than 1000 feet in less than ½ mile), further indicates limited permeability of the intervening bedrock. If bedrock hydraulic conductivity in the southern portion of the West Ridge were higher, or if localized higher permeability fracture zones were present south of the ridge, the steep gradients observed between the West Ridge and historic mine workings most likely would not occur.

In addition to the apparent absence of (or minimal) hydraulic connection between the West Ridge bedrock system and historic mine workings to the south, other regional-scale information suggests a lack of high permeability structures or zones within the West Ridge. As previously noted, well yields recorded during monitoring well drilling and sampling, and results of the more than 100 aquifer tests conducted to date (Section 3), all indicate a bedrock system of consistent moderate to low hydraulic conductivity (10^{-6} to 10^{-8} m/sec). Similarly, residential wells throughout the West Ridge area are invariably low yielding with most wells yielding 10 gpm or less from depths of 200 to 500 feet. In addition, an inventory of springs, seeps, and surface water features along the west flank of the West



HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA

REGIONAL HYDROLOGIC SETTING AND FEATURES

FIGURE 4-2

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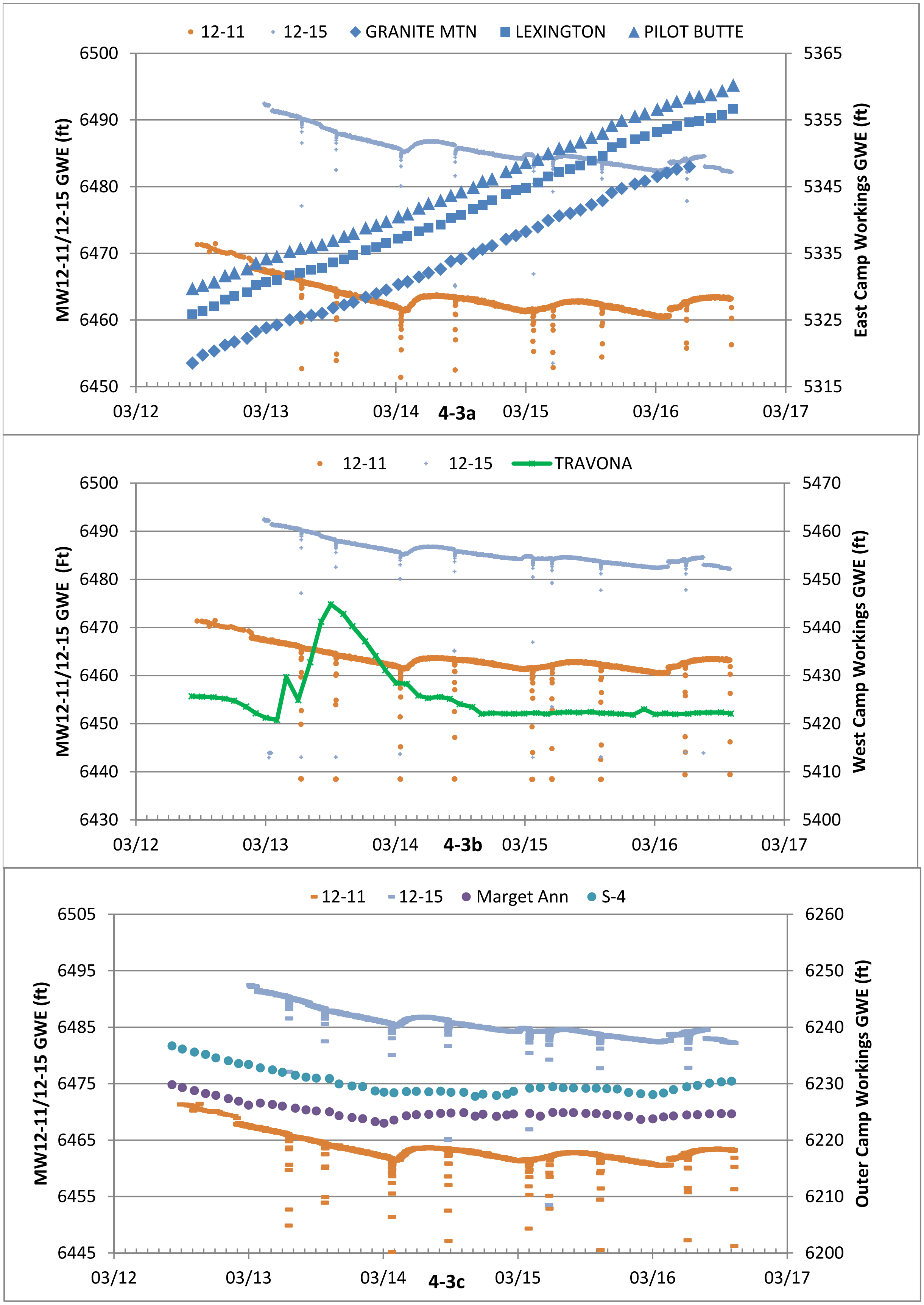


Figure 4-3. Hydrographs of West Ridge Monitoring Wells Compared to a) East Camp Workings; b) West Camp Workings; c) Outer Camp Workings

Ridge reveal no significant hydrologic features between the ridge crest and Browns Gulch, located approximately four miles to the west and more than 1000 feet lower in elevation than the ridge (850 to 900 feet lower than the West Ridge groundwater elevations). Measured baseflow in Oro Fino Gulch and Bull Run Creek west of the ridge is typically on the order of 10 gpm or less. The lack of significant springs/seeps and very low streamflow rates west of the ridge further suggests an absence of east-west oriented high permeability zones traversing the West Ridge. If such structures existed, they would likely be expressed as springs or other distinct hydrologic features where the structures daylight.

4.2 GENERAL HYDROLOGY OF IMPOUNDMENT AREA

The YDTI is surrounded to the north and east by steep forested terrain, to the west by the West Ridge, and to the south by the former Silver Bow Creek drainage and current MR and historic mining facilities (Figure 1-2). Although recent investigations have focused on the West Ridge area, data collection has also occurred to the north and east of the impoundment, and extensive information is available for the area south of the YDTI through MR's operational monitoring program and ongoing CERCLA activities.

4.2.1 East of YDTI

The YDTI is bordered on the east by steep rocky terrain of Rampart Mountain. The ground surface rises steeply to the crest of Rampart Mountain (also referred to as the East Ridge) with ridge crest elevations of about 7700 feet. There are no perennial surface water drainages along the East Ridge although seasonal springs and seeps do occur along its west flank.

Monitoring wells MW15-12 and MW15-13 were completed along the east side of the YDTI in August 2015 to provide information on current groundwater depths and quality in that area (Figure 3-1). Both wells are located approximately 100 feet higher than the current pond level and are completed to about 100 feet bgs (Table 3-1). Drilling at each site encountered BQM bedrock from ground surface to the total completion depths with an aplite dike encountered from 45 to 51 feet in MW15-12 and a gouge-rich shear zone from 71 to 83 feet in MW15-13 (see well logs, Appendix C). Since completion, water levels have been relatively stable in both wells with depths to water about 58 and 54 feet in MW15-12 and 15-13, respectively (see water level data, Appendix B). These water levels equate to groundwater elevations of about 6375 feet, or 40 feet higher than the current pond level, and a hydraulic gradient of 0.1 ft/ft towards the pond. This relatively steep gradient is indicative of a low bedrock hydraulic conductivity, similar to the West Ridge area.

4.2.2 North of YDTI

The area north of YDTI is moderately to steeply south sloping, heavily timbered, with abundant BQM bedrock outcroppings. The area includes two primary drainages, Yankee Doodle Creek and Silver Bow Creek, and the smaller Dixie Creek drainage (Figure 1-2). Silver Bow and Yankee Doodle Creek drainages both extend southward to the continental divide with elevations in the upper drainages exceeding 7200 feet and 7700 feet, respectively. The total drainage area north of the YDTI is approximately 5200 acres (KP, 2017b).

Three monitoring wells were completed north of the YDTI in July/August 2015 including MW15-09 (142 feet deep), MW15-10 (100 feet), and MW15-11 (201 feet, Figure 3-1). MW15-09 is located northwest of the impoundment and encountered relatively hard, competent BQM to the total depth of drilling. MW15-10 and MW15-11 are located to the east near Silver Bow Creek and encountered alternating BQM and aplite/granoaplite during drilling (see well logs, Appendix C). These wells are located in an area of aplite outcroppings as shown on Figure 2-1. Depths to water in the three northern wells range from about 30 feet bgs at MW15-10, located closest to the current tailings pond, to about 160 feet at MW15-11 located furthest from the pond and at the highest elevation. Groundwater elevations range from about 6410 feet at MW15-09, to 6338 at MW15-10, to 6376 at MW15-11 (Appendix B). In addition to the monitoring wells, groundwater levels have been recorded in three exploration drillholes completed south of MW15-10 and 15-11. Drillholes 514409, 516409, and 516410 (Figure 3-1) are completed as open holes in granopalite to total depths of 112, 119 and 129 feet, respectively. Depths to water in the three drillholes range from about 110 to 130 feet with corresponding groundwater elevations of about 6590.

Hydraulic gradients within the bedrock north of the YDTI vary with location. Northwest of the tailings pond, the groundwater elevation at MW15-09 is approximately 6410 feet equating to a hydraulic gradient of about 0.05 ft/ft towards the pond. Northeast of the pond, the groundwater elevation at MW15-11 is about 6375 equating to a similar gradient of 0.05 ft/ft towards the pond. Groundwater elevations at exploration drillholes 514409, 516409, and 516410 are significantly higher than at the monitoring wells, about 6590 feet, equating to a hydraulic gradient of approximately 0.2 ft/ft towards the pond.

Figures 3-4 and 3-5 include seasonal potentiometric maps for the YDTI and surrounding area. As shown on the figures, and described above, groundwater flow directions north, east and west of the YDTI are towards the impoundment. The significant drainage areas and higher topography and groundwater elevations north and east of the YDTI will ensure long-term hydrodynamic containment in these areas under the ultimate proposed tailing pond level of 6429 feet due to ambient hydraulic gradients.

4.2.3 Tailings Hydrology

As shown in Figures 3-4 and 3-5, groundwater hydraulic gradients north, east and west of the YDTI all slope inward towards the impoundment and three perennial streams flow into the tailings pond from the north. Besides groundwater and surface water, inflow to the YDTI includes the tailings slurry, incident precipitation and hillslope runoff. Outflow from the impoundment includes evaporation, reclaim water from the decant pond for use in mine operations, and seepage through the East-West Embankment to the south. Seepage through the embankment drains to Horseshoe Bend where it is captured and treated by MR at the facility water treatment plant.

KP conducted multiple investigations of the YDTI between 2012 and 2015 (KP, 2017a). Based on the investigation results, as well as information on the pre-YDTI topography, geology and drainage conditions, materials present within and beneath the YDTI include native residual soil, bedrock and alluvium/colluvium representing the pre-YDTI ground surface, fine grained tailings slimes overlying the native materials, and tailings beach sands overlying the slimes. Spigotting of tailings from the south end of the impoundment has resulted in the tailings package of slimes overlain by sands prograding from south to north in a general deltaic pattern. As a result, the tailings pond is currently confined to the northern portion of the YDTI. The resulting generalized depositional pattern of the various materials is shown in Figures 4-4 and 4-5.

KP (2017a) estimated hydraulic conductivity values for the tailings sands and slimes based on the normalized soil behavior type and/or pore pressure dissipation testing obtained during the tailings investigations. Both of these methods are reported to provide "order of magnitude" estimates of material hydraulic conductivities. Test results indicate hydraulic conductivity values for the tailings sands ranging from 2.9 to 0.02 ft/day (10^{-5} to $7*10^{-7}$ m/sec), and 0.003 to 0.0009 ft/day ($9*10^{-9}$ to $3*10^{-9}$ m/sec) for the slimes. The relatively large range for the tailings sands is due to the varying silt content of the materials with depth and location within the impoundment.

KP (2017a) installed a number of VWPs within the tailings in various portions of the YDTI (Figure 4-4). Based on the phreatic surface elevation of about 6285 feet at CPT15-03 near the East-West Embankment in 2016, a corresponding pond elevation of 6333, and a horizontal distance of 6300 feet, the phreatic surface slopes about 0.008 ft/ft southward through the tailings beach. The phreatic surface and groundwater movement through the existing tailings beach provides insight into how the tailings beach to be developed along the West Embankment may affect seepage through the west beach and resulting hydrostatic heads along the West Embankment. This issue is discussed further in Section 4.5.

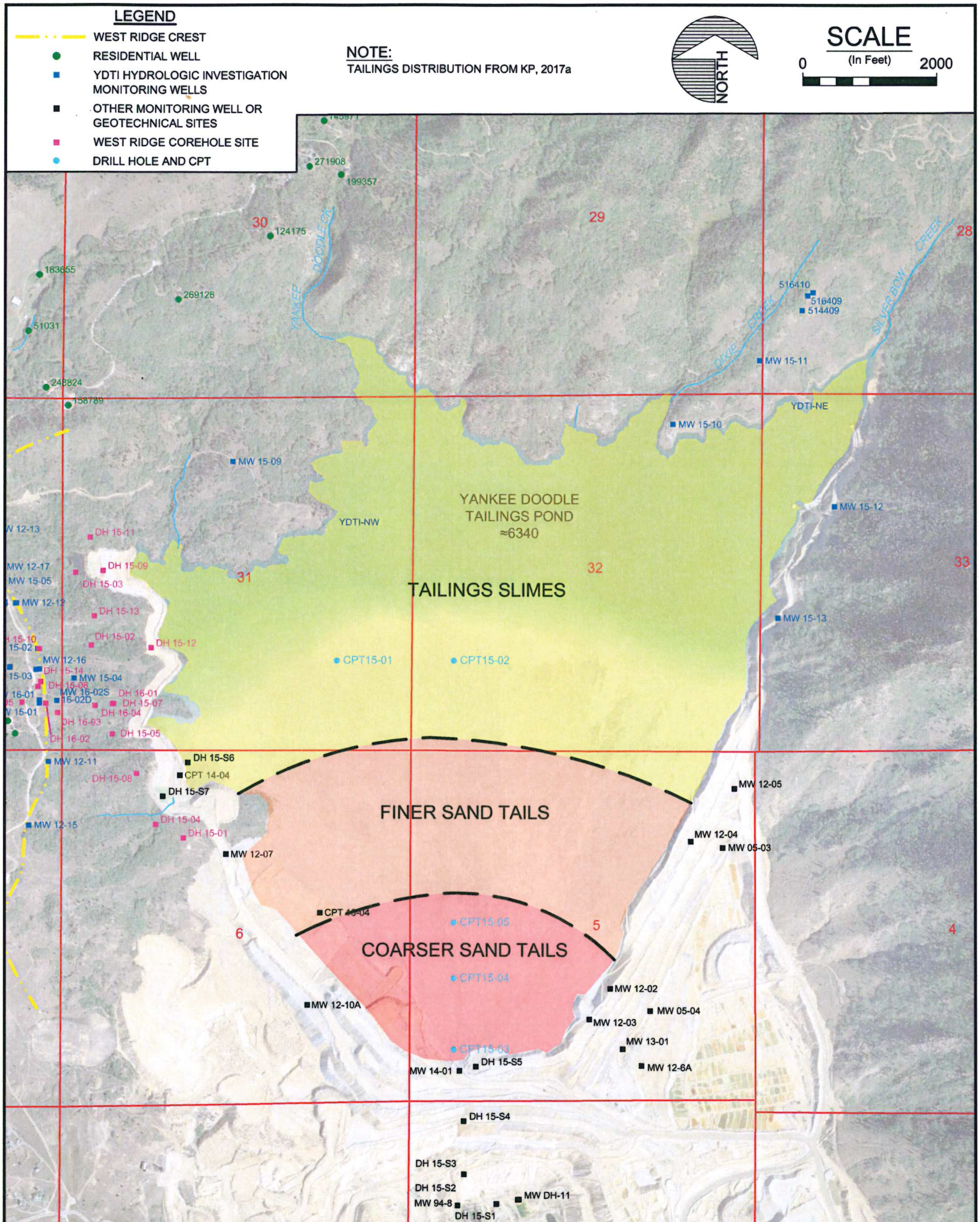
4.3 GEOLOGIC MODEL OF DEEP ISOLATED FRACTURE SYSTEM

As discussed in Section 3, discovery of the lower piezometric heads in the deep isolated fracture system led to an extensive investigation program in 2016 for the purpose of delineating the lateral and vertical extent of the fracture system and its hydraulic properties. Key components of the fracture system characterization include:

- Completion of four angle and one vertical diamond drillhole for bedrock core logging;
- Packer testing and VWP installation;
- Completion of two monitoring wells within the fracture system and a third shallower well in the overlying West Ridge bedrock system; and
- Implementation of a long-term (14-day) pumping test.

Besides the pumping test results discussed in Section 3.5, a key product of the investigation is a structural geology model of the deep isolated fracture system and surrounding area developed by KP (KP, 2017a).

The structural geology model was developed through delineation of structural features in the drillhole core, test pits/trenches, surficial mapping, and projection of structures based on location and



HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA

GENERALIZED TAILINGS DEPOSITIONAL MODEL

FIGURE 4-4

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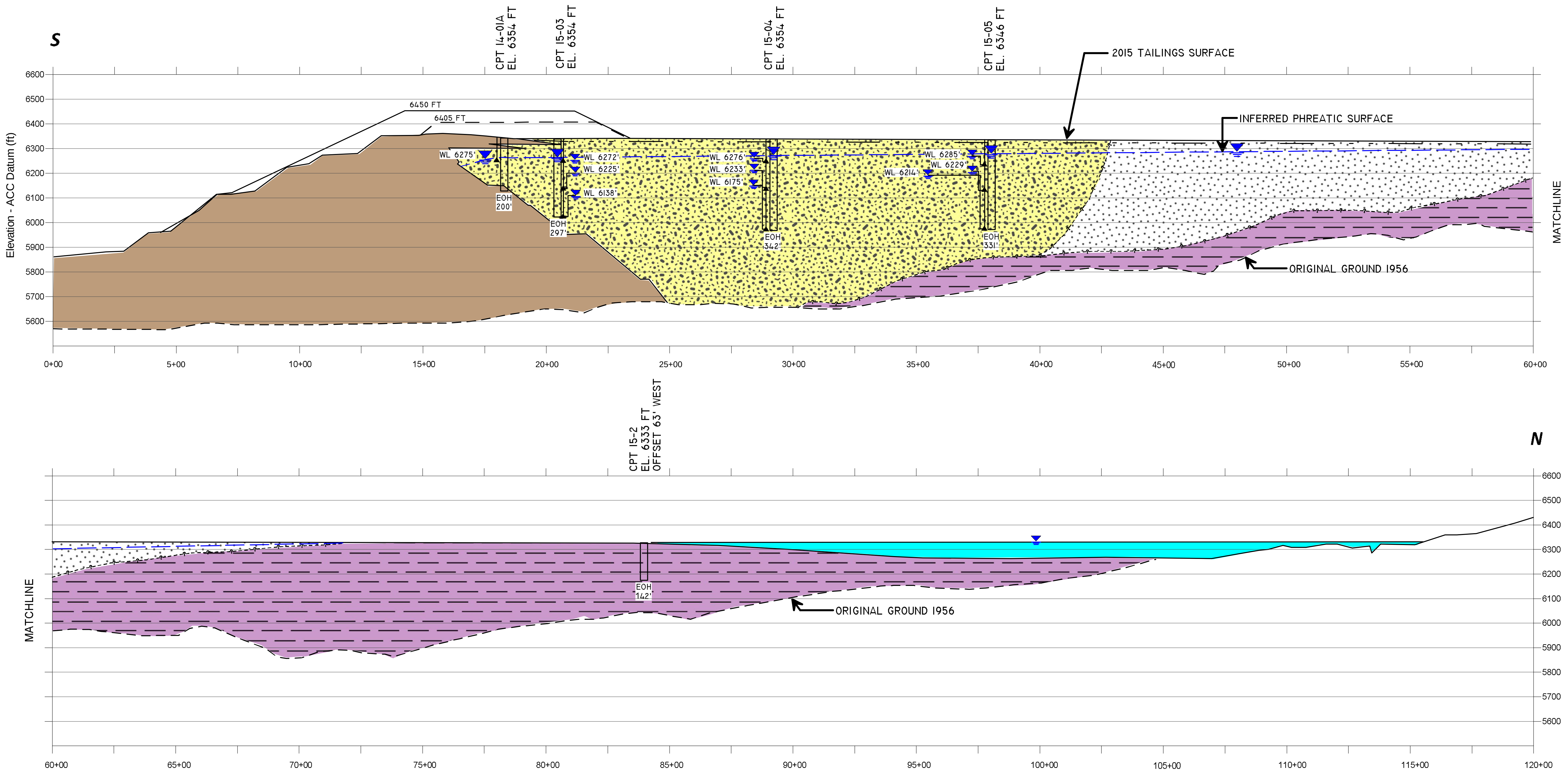


LEGEND

- TAILINGS SAND (COARSER)
- TAILINGS SAND (FINER)
- TAILINGS SLIMES
- SUPERNATANT POND

NOTES:

1. TAILINGS MATERIAL DISTRIBUTION INTERPRETED FROM NORMALIZED SOIL BEHAVIOR TYPE (SBTn) CLASSIFICATION FROM SPT SOUNDINGS.
2. VWP DATA REPRESENTS READINGS TAKEN ON OCTOBER 26, 2016 EXCEPT: CPT15-05 WAS LAST DOWNLOADED ON JULY 11, 2016 AND CPT15-06 WAS LAST DOWNLOADED ON MAY 4, 2016
3. ELEVATIONS ARE IN REFERENCE TO ANACONDA MINE GRID
4. SUPERNATANT POND ELEVATION REPRESENTS THE ELEVATION DURING THE PHASE 4 2015 SITE INVESTIGATION. THE CURRENT POND ELEVATION IS APPROXIMATELY 6340 ft.

Figure adapted from KP, 2017a (Figure 5.3 - Tailings Material Distribution - Section 1).

HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA SILVER BOW COUNTY, MONTANA	**GENERALIZED NORTH-SOUTH CROSS SECTION THROUGH TAILINGS IMPOUNDMENT**	**FIGURE 4-5**

K:/PROJECT/12020/Amendment 10 Application/Surfer/YDTI_Xsec.srf orientation between the various drillholes or surface expressions. Structural features of primary interest include zones of increased fracturing that could act as preferential flow paths, and zones of altered bedrock referred to as shear zones. The numerous shear zones encountered in drillholes are typically characterized by the presence of clay gouge and mineral alteration envelopes around the gouge. The shear zones are significant due to their lower permeability (minimum one order of magnitude lower hydraulic conductivity than surrounding bedrock, Section 3.5), and restrictions to groundwater flow.

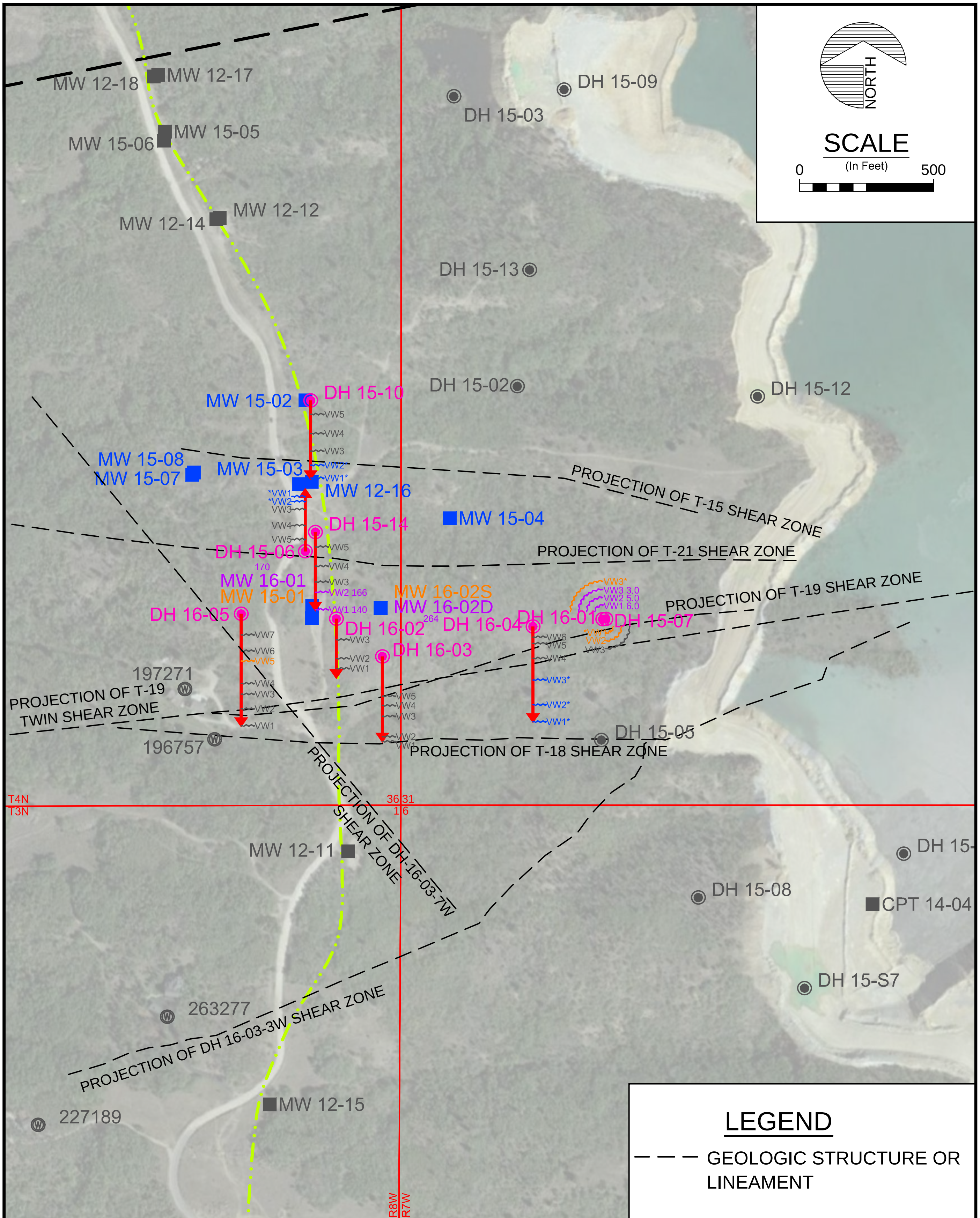
4.3.1 Deep Isolated Fracture System Boundaries

Four primary structures associated with the deep isolated fracture system were identified through the investigation. The structures include two steeply dipping, predominantly east-west oriented shear zones, a steeply dipping northwest-southeast oriented shear zone, and a shallow dipping east-west structure. These four structures have been identified as boundaries to the deep isolated fracture system and help explain the pattern of water level response to the long-term pumping test described in Section 3.5.3. The four main structures are described in Table 4-1, along with other structures identified through the investigation program that are believed to explain other observed anomalies in the West Ridge bedrock groundwater levels. The surface expression of the structures is shown on Figure 4-6 and a three-dimensional rendering of the geologic structures, developed by KP using the Surpac and Muck3D software packages, are included in Figure 4-7.

TABLE 4-1. CHARACTERISTICS OF HYDROGEOLOGICALLY SIGNIFICANT GEOLOGIC STRUCTURES

Structure Designation	General Orientation	Dip Angle	Hydrogeologic Influence
T-19 Shear	E-W	45 to 55 N	North boundary of deep isolated fracture system
T-19 Twin Shear	E-W	73N	South boundary of deep isolated fracture system
7W Shear	NW-SE	76NE	West boundary of deep isolated fracture system
3W Shear	SW-NE	25N	Upper boundary of deep isolated fracture system
T21 Shear	E-W	80N	South boundary of potentiometric low
T15 Shear	E-W	60 to 60N	North boundary of potentiometric low

Structures bounding the deep isolated fracture system to the north and south include the east-west trending, northward dipping T19 and T19 Twin shear zones, respectively (Figures 4-6 and 4-7). Both of these shears were identified in exploration trenches and verified in drillhole core. As shown in Figure 4-7, these structures are subparallel, cross at depth, and may be syngenetic. This relationship is also shown in Figures 4-8 and 4-9, schematic N-S and E-W cross sections of the West Ridge area, respectively.



HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA	SURFACE TRACES OF HYDROGEOLOGICALLY SIGNIFICANT GEOLOGIC STRUCTURES	FIGURE 4-6

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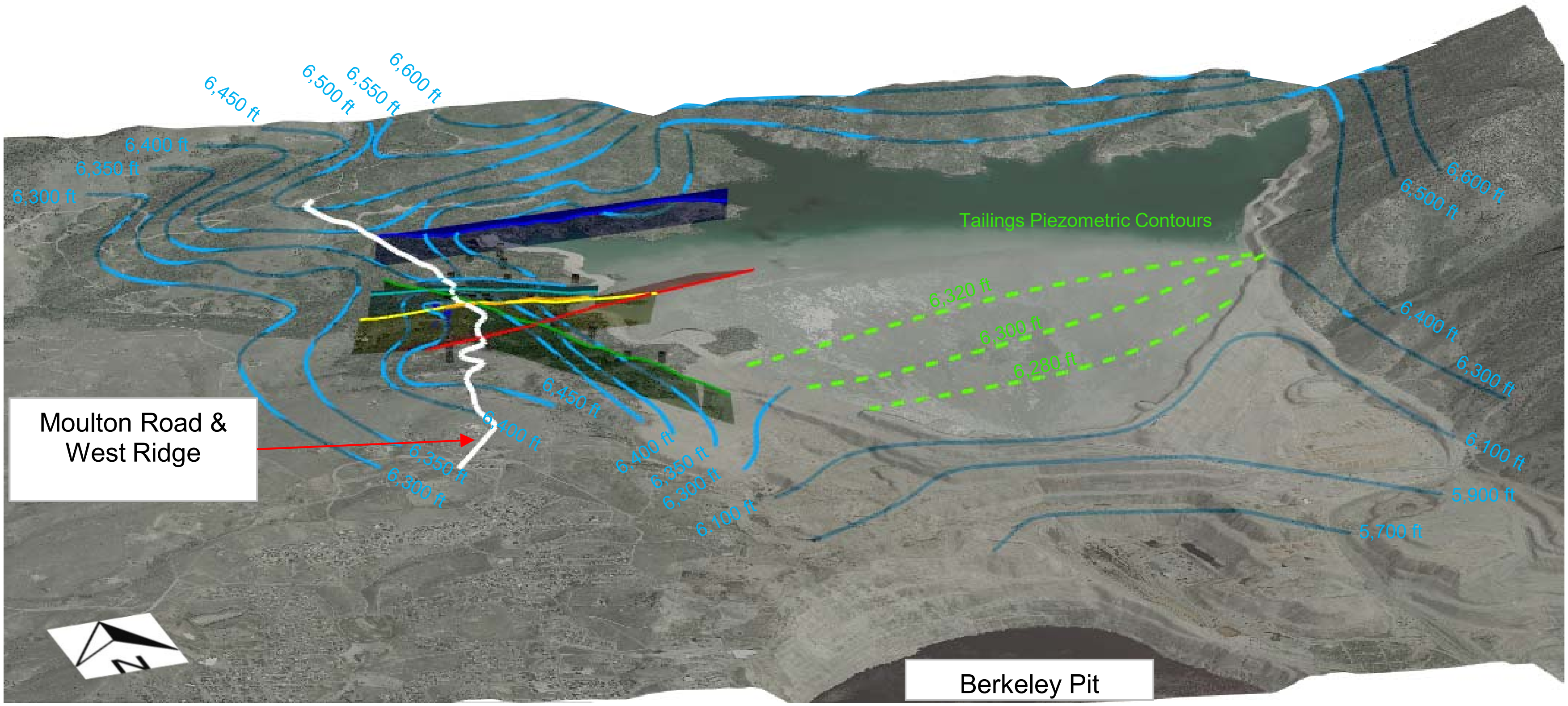
M:\1\01\00126\14\A\Report\2 - YDTI Site Characterization Report\Rev 0\Figures\Excel Versions\[Figure 3.16 West Ridge 3D Model Figures - 2016-12-17]Figure 3.16   Print 3/6/2017 10:15 AM



NOTES:

1. SURFACE TOPOGRAPHY IS SHOWN WITH A 20 FT CONTOUR INTERVAL AND 100 FT INDEX CONTOURS.
2. THE WEST RIDGE RIDGELINE AND INFERRED GROUNDWATER DIVIDE ARE APPROXIMATELY COINCIDENT WITH THE ALIGNMENT OF MOULTON ROAD SHOWN ABOVE.
3. STRUCTURAL LINEAMENTS SHOWN ABOVE ARE COLOR CODED AS FOLLOWS:
   - LINEAMENT 1
   - T-15 SHEAR
   - T-21 SHEAR
   - T-19 SHEAR
   - T-19 TWIN SHEAR
   - 3W SHEAR
   - 7W SHEAR
4. DRILLHOLES AND MONITORING WELLS ARE SHOWN AS BLACK TRACES; RESIDENTIAL WELLS ARE SHOWN AS BLUE TRACES.
5. BLUE CONTOURS ARE POTENTIOMETRIC CONTOURS OF THE BEDROCK GROUNDWATER SYSTEM FOR OCTOBER 2016 AND WERE DEVELOPED BY HYDROMETRICS.

Modified from KP, 2017a

REV	DATE	DESCRIPTION	PREP'D	RVW'D
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MONTANA RESOURCES LLP.

YANKEE DOODLE TAILINGS IMPOUNDMENT

GEOLOGIC STRUCTURES AND POTENTIOMETRIC CONTOURS OF BEDROCK GROUNDWATER SYSTEM AND YDTI TAILINGS

Knight Piésold CONSULTING

P/A NO. VA101-126/14

REF. NO. 2

FIGURE 4-7

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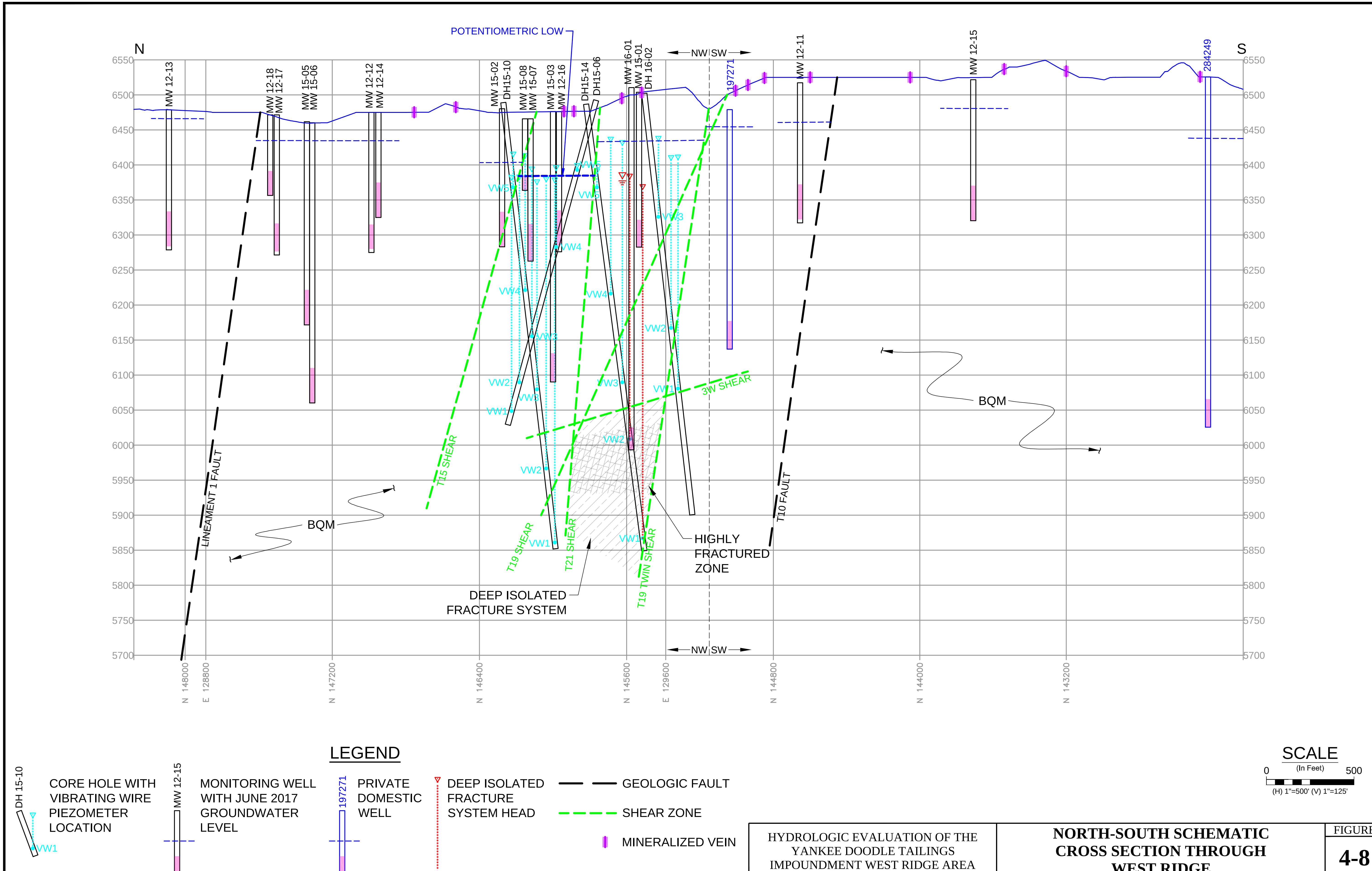

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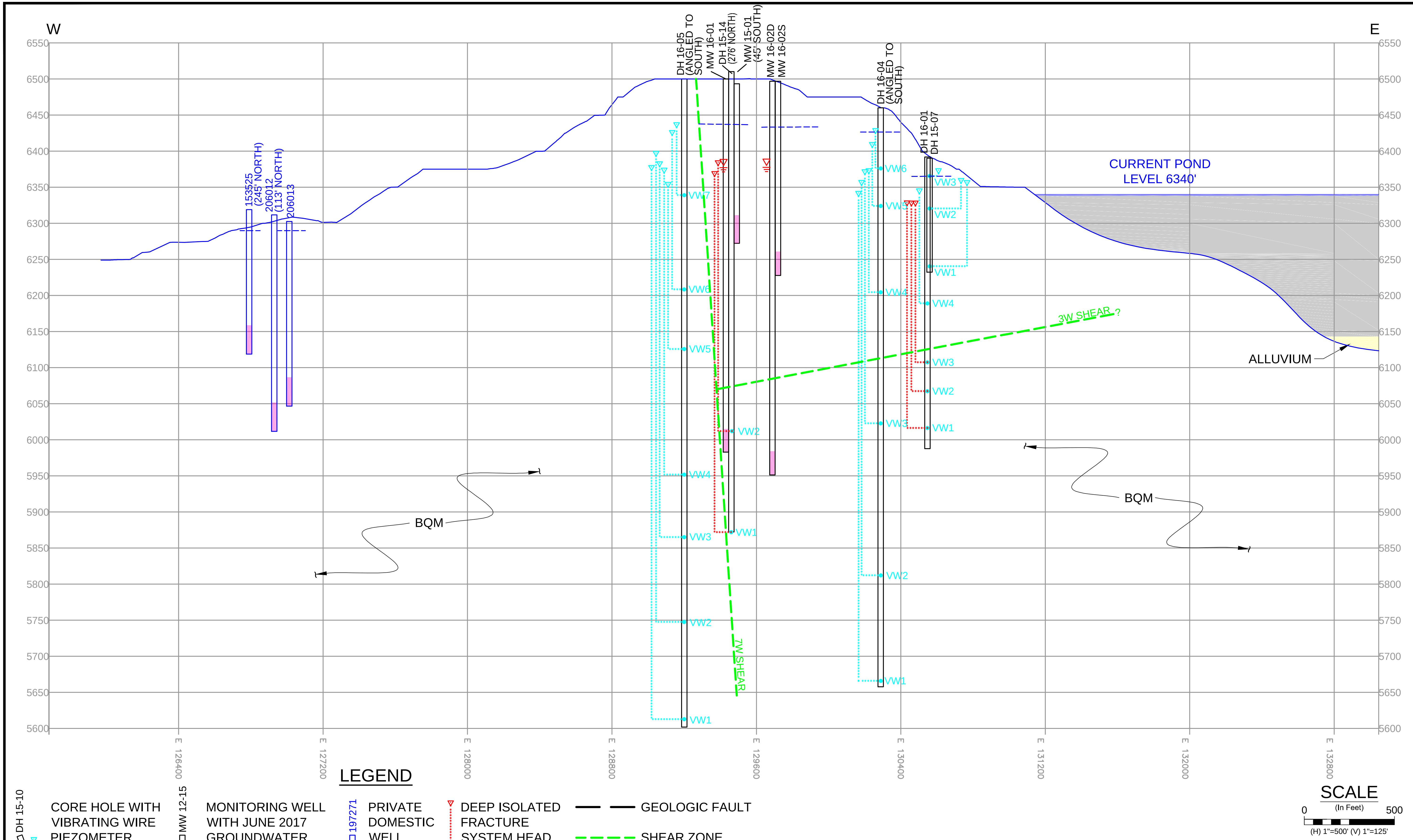

HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA

EAST-WEST SCHEMATIC CROSS SECTION THROUGH WEST RIDGE

FIGURE

4-9

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The 7W shear is a NW/SE trending structure dipping steeply to the northeast. This structure forms the western boundary to the deep isolated fracture system and is responsible for the lack of direct water level response noted at the DH16-05 VWPs during the long-term pumping test. The delayed response noted at VWP5 in DH16-05, located at elevation 6126 ACC, indicates that some seepage may occur through the 7W shear at that level.

The 3W Shear is an east-west shallow north dipping structure with the surface expression coinciding closely with the Lineament 2 trend. The 3W shear extends northward forming the upper boundary to the deep isolated fracture system, at a depth of approximately 400 feet (elevation 6100 ACC) at the fracture system location. This structure is responsible for the lack of direct response to the long-term pumping test at wells MW15-01 and MW16-02S, completed above the fracture zone and 3W shear. The delayed response observed in both of these wells suggests that some leakage occurs through this structure in response to hydraulic head differences, representing a source of recharge to the deep fracture system.

The structural geology model developed by KP, based on the extensive surficial and subsurface geologic data, provides detailed information on the structural framework of the BQM bedrock in the vicinity of the deep isolated fracture system, and identifies the bounding structures believed to confine the fracture system to the north, south, west, and top. The locations of these bounding structures coincide with the lateral and vertical distribution of water level responses observed during the long-term pumping test (Section 3.5.3).

4.3.2 Other Groundwater Influencing Structures

A number of other structures influencing groundwater flow in the West Ridge bedrock groundwater system have also been identified. The T21 shear zone, named for Trench #21 where it was identified, is an east-west trending, steeply north dipping shear zone characterized by highly altered BQM and abundant clay gouge. The presence of this structure was predicted from the water level responses to the long-term pumping test and confirmed through the trenching program. The T21 shear crosses the West Ridge just south of drillhole DH15-06 (a north oriented angle drillhole), and between VWP 4 and 5 in south-dipping angle hole DH15-14 (Figure 4-8). This low permeability structure is responsible for the lack of response in VWP5, the uppermost VWP in DH15-14, during all drilling, pumping and recharge testing conducted to the south, while all deeper VWPs responded to one or more of these stresses. Based on its physical characteristics and potentiometric surface patterns (a steep drop in groundwater elevations from south to north of the structure), the T21 shear appears to form a more competent barrier to groundwater flow and be responsible in part for the anomalous potentiometric low in the central portion of the ridge (Figure 4-8).

A second east-west trending shear zone, the T15 shear, crosses the West Ridge about 500 feet north of the T21 shear. First identified in Trench 15 located along the east flank of the ridge near the West Embankment, the existence of the T15 shear near the ridge crest was predicted from the observed water level trends and confirmed through excavation of Trenches 23, 24, and 25 (Figure 3-3). Similar to the T21 shear, the T15 shear is believed to represent a low permeability zone restricting groundwater flow, inhibiting southward flow of groundwater through the ridge, and contributing in part to the groundwater potentiometric low.

4.4 HYDROGEOLOGIC CONCEPTUAL MODEL

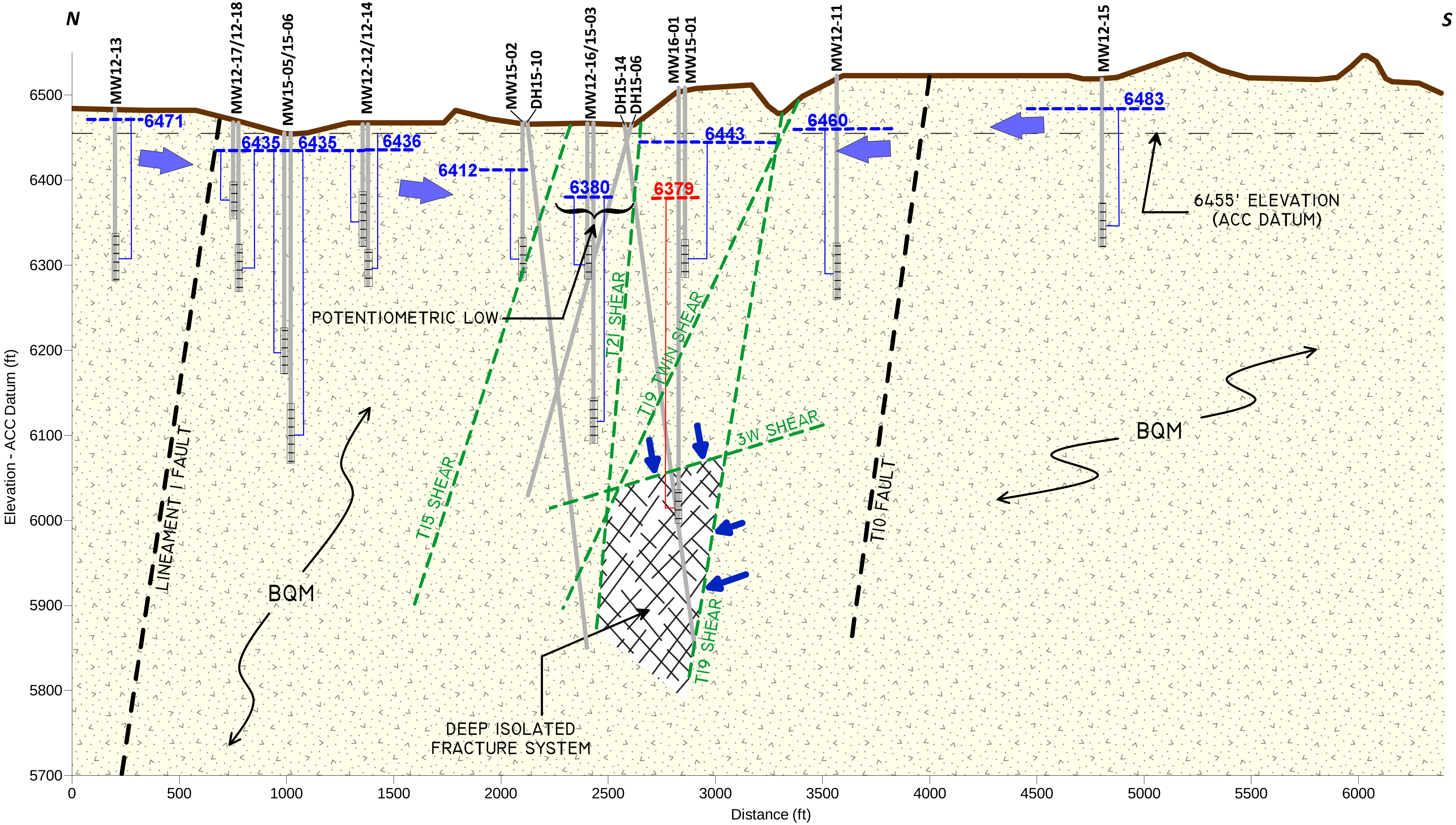
Based on the West Ridge hydrogeologic evaluation results, a conceptual site model (CSM) of groundwater flow throughout the West Ridge is presented below. The groundwater flow CSM incorporates information on the West Ridge structural geology and bedrock hydrologic properties, and addresses the occurrence of the groundwater potentiometric low and deep isolated fracture system. The CSM also serves as the basis, along with the West Embankment design and YDTI operational plan, for evaluating the potential for continued hydrodynamic containment along the West Ridge under future YDTI operations.

4.4.1 West Ridge Bedrock Groundwater System

Based on extensive drilling and testing, the West Ridge bedrock groundwater system is a double porosity, semi-confined fracture flow system. Average annual depths to groundwater in site monitoring wells range from 17 feet at the north end, to about 110 feet in the middle of the ridge. Average annual groundwater elevations range from about 6485 feet at the south end, to 6380 feet in the middle of the ridge. Water level responses in wells when adjacent paired wells are pumped, as well as information obtained through extensive bedrock core drilling indicates that the bedrock is continuously saturated from the top of the saturated zone (i.e., water table) to depths of at least 700 feet, the maximum depths of drilling. The continuous saturated conditions down to elevations of 5800 feet or less indicate that the West Ridge bedrock groundwater system is a single continuous system with no intervening unsaturated zones. The continuous nature of the groundwater system is important in evaluating and maintaining hydrodynamic containment as discussed in Section 4.5.

Results of three multi-day constant discharge pumping tests and more than 100 packer tests indicate that the hydraulic conductivity for competent BQM bedrock ranges from $<1*10^{-8}$ to $6*10^{-6}$ m/sec and averages $3*10^{-7}$ m/sec ($8.5*10^{-2}$ ft/day). As previously discussed, numerous structures were identified during drilling including predominantly steeply dipping clayey shear zones. Results of 12 packer tests completed on intervals spanning shear zones show a geometric mean hydraulic conductivity of $3*10^{-8}$ m/sec ($8.5*10^{-3}$ ft/day), about an order of magnitude lower than the competent BQM bedrock (KP, 2017a).

Prior to the recent West Ridge investigations, the initial hydrologic CSM for the West Ridge included a potentiometric surface sloping continuously from north to south with the primary source of recharge being lateral groundwater inflow from uplands to the north. However, discovery of the potentiometric low near the middle of the ridge is inconsistent with that model. Based on information collected since 2012, the CSM has been updated to include, from north to south, a series of bedrock blocks separated by east-west trending low permeability shear zones with the shear zones restricting southward flow of groundwater through the ridge. Figure 4-10 shows this arrangement of compartmentalized bedrock blocks and the effect of the bounding structures on groundwater flow and levels. As shown on the figure, groundwater levels are higher at the north end of the ridge and decrease in a stair-step fashion to the south as low permeability shear zones are encountered. Significant drops in the potentiometric surface occur across Lineament 1, previously described as a likely restriction to groundwater flow (Section 2), and across the T15 shear. These head losses across shear zones are responsible in part for the central groundwater potentiometric low. It should be noted



LEGEND

Generalized Groundwater Flow Direction

Deep Isolated Fracture System Recharge

6443 Average 2016 Groundwater Elevation

6379 June 16, 2017 Deep Isolated Fracture System Potentiometric Head

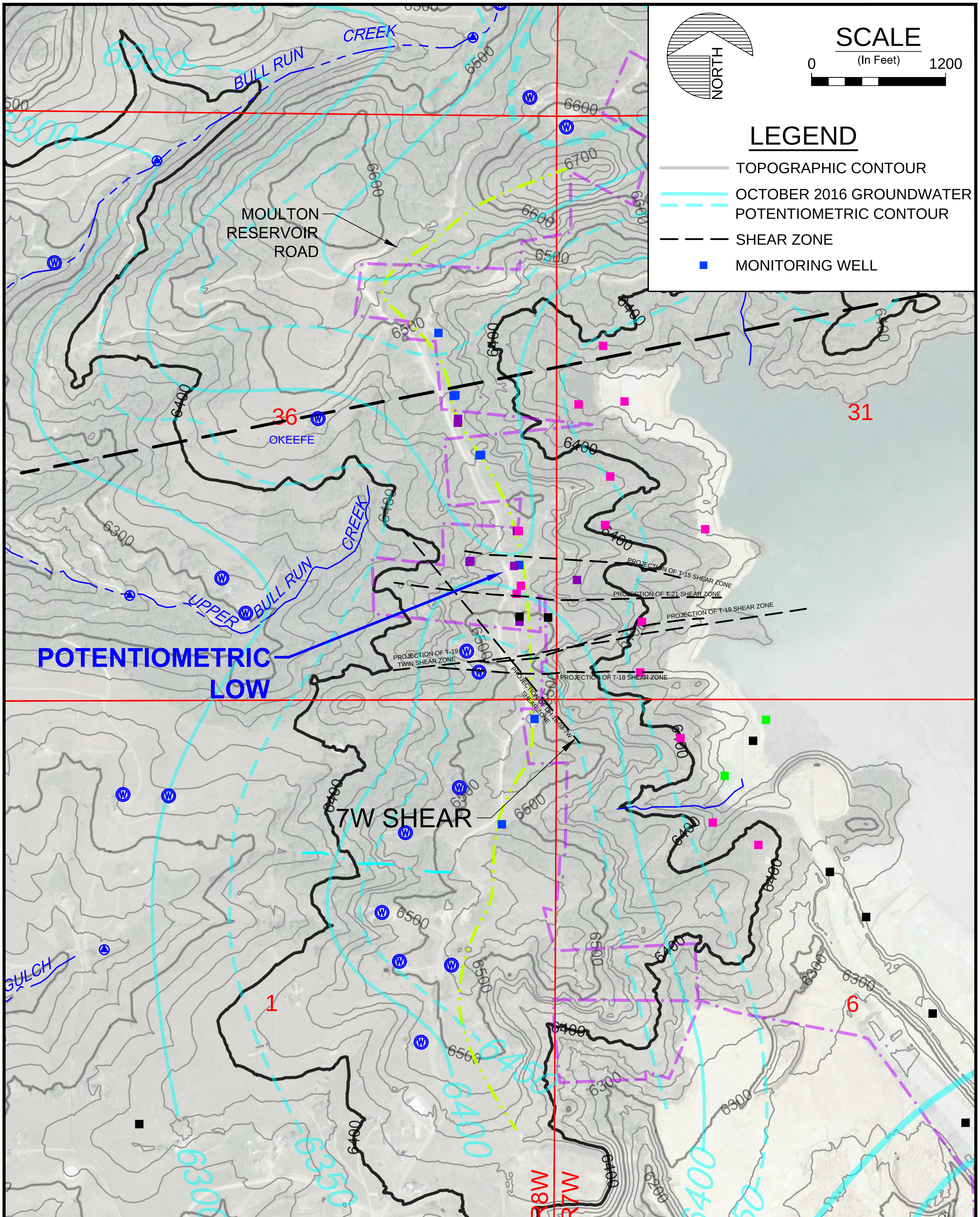
HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA SILVER BOW COUNTY, MONTANA	**GENERALIZED NORTH-SOUTH CROSS SECTION OF WEST RIDGE BEDROCK BLOCKS**	**FIGURE** **4-10**

K:/PROJECT/12020/Amendment 10 Application/Surfer/Fig4-10_N-SGeneralizedXsec.srf that Figure 4-10 shows only the structures identified through the West Ridge investigation program. Other flow inhibiting structures may exist and contribute to the lower water levels at the potentiometric low, such as between MW12-12/12-14 and MW15-02, where average 2016 water levels decline by about 25 feet.

As shown in Figure 4-10, groundwater levels increase from the central potentiometric low to the south end of the ridge. A similar stair-stepped decline in groundwater levels is apparent from southern-most monitoring well MW12-15 towards the potentiometric low. This is particularly apparent across the T21 shear where water levels decline more than 60 feet in a distance of a few hundred feet or less. The large drop in water levels indicates that the T21 shear is a particularly competent restriction to groundwater flow. The presence of this low permeability shear was evident even before the T21 shear was identified, based on the lack of response at monitoring sites north of T21 to the significant stresses applied to both the bedrock groundwater system and deep isolated fracture system south of T21 through the 2016 drilling and aquifer testing programs.

As noted above, the higher groundwater levels in the south portion of the ridge are somewhat anomalous in regard to the original CSM where the assumed primary source of recharge throughout the West Ridge was lateral groundwater inflow from the north. The observed potentiometric trends are best explained by a series of east-west oriented low permeability structures restricting flow as identified through the West Ridge investigation and shown in Figure 4-10, with local precipitation recharge of individual bedrock blocks or compartments. In general, recharge from incident precipitation and snowmelt is dependent on the annual precipitation rate, the percentage of deep percolation or recharge, and the surface area of recharge. As shown in Figure 4-11, the topography along the West Ridge narrows significantly in the vicinity of the potentiometric low and widens to the south. The greater width to the south increases the surface area for potential precipitation recharge. Furthermore, the flatter topography likely increases the recharge rate per unit area in the south as compared to the potentiometric low. This information suggests that recharge from incident precipitation and snowmelt is greatest in the southern portion of the ridge and lowest in the vicinity of the central potentiometric low due to decreased recharge rates in that area. These topographic and potentiometric patterns are consistent with a model of the compartmentalized bedrock blocks recharged primarily by incident precipitation and snowmelt.

The West Ridge bedrock groundwater system chemistry is also useful in evaluating groundwater flow patterns. As described in Section 4.2.1, the 7W shear acts as a restriction to westward groundwater flow in the vicinity of the potentiometric low and deep isolated fracture system. The lack of response at drillhole DH16-05, located west of Moulton Reservoir Road, to the log-term pumping test (Section 3.5), indicates a restriction to groundwater flow coinciding with the 7W shear. As shown on Figure 4-11, the southward projection of the 7W Shear crosses the West Ridge south of the potentiometric low and water chemistry trends appear to support the presence of a restriction to flow in this area. Figures 4-12 and 4-13 show the spatial distribution of silica and strontium in groundwater, two constituents that exhibit differing concentrations south of the 7W shear as compared to the central and north ridge. Constituent concentrations (represented by the colored dots) show distinct trends across the 7W shear, with silica concentrations lower and strontium higher



HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA	**WEST RIDGE TOPOGRAPHY AND GEOLOGIC STRUCTURES**	FIGURE **4-11**

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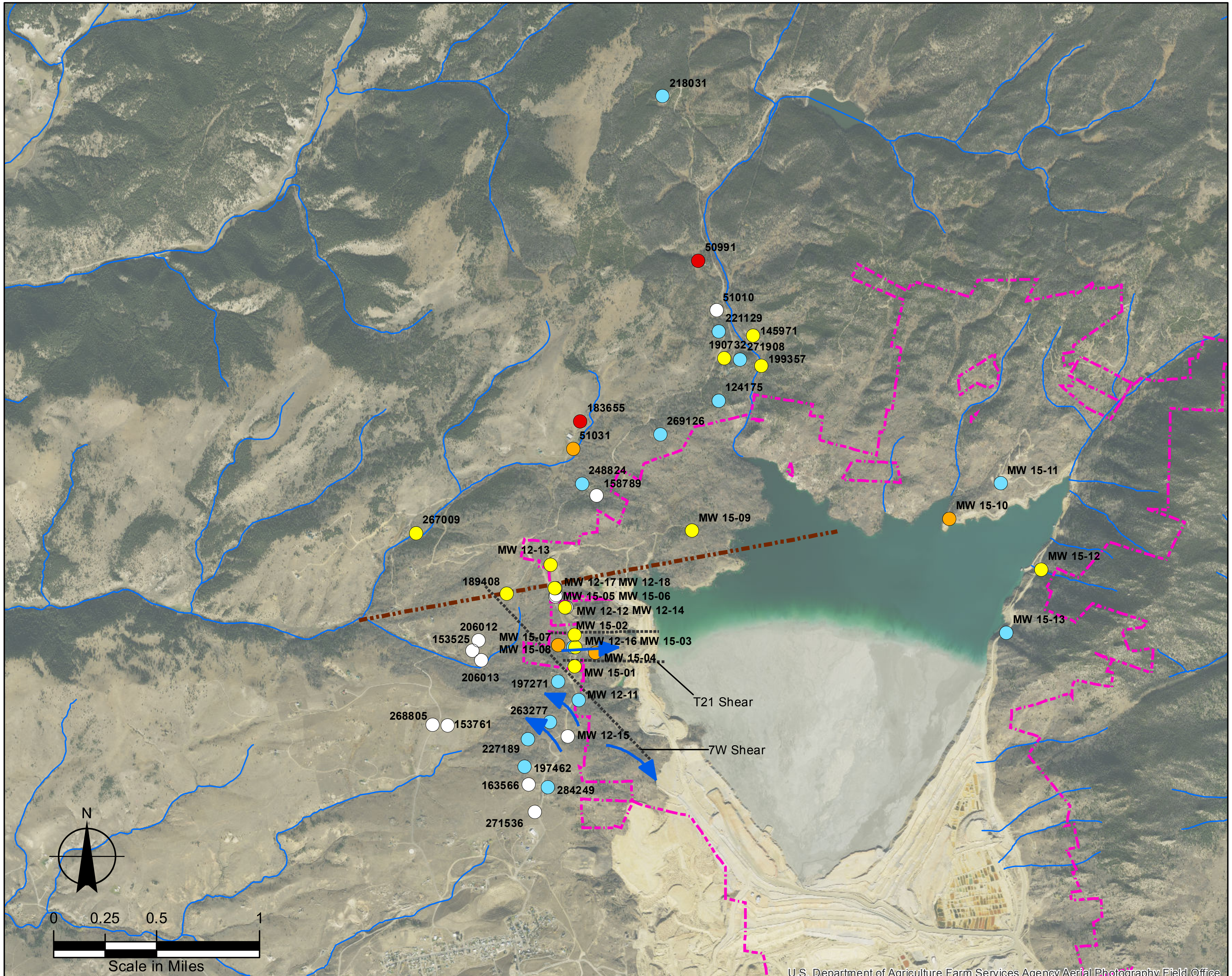

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Inferred Groundwater Flow Direction

Average SiO2 Concentration (mg/L)

- < 15 (14)
- 16 - 20 (15)
- 21 - 30 (14)
- 31 - 40 (4)
- > 40 (2)
- Shear Zone
- Lineament 1
- Mine Property Boundary

NOTES:

Numbers in parentheses indicate number of wells with concentrations in the indicated range.

Average concentrations from 2012-2016 Monitoring Programs.

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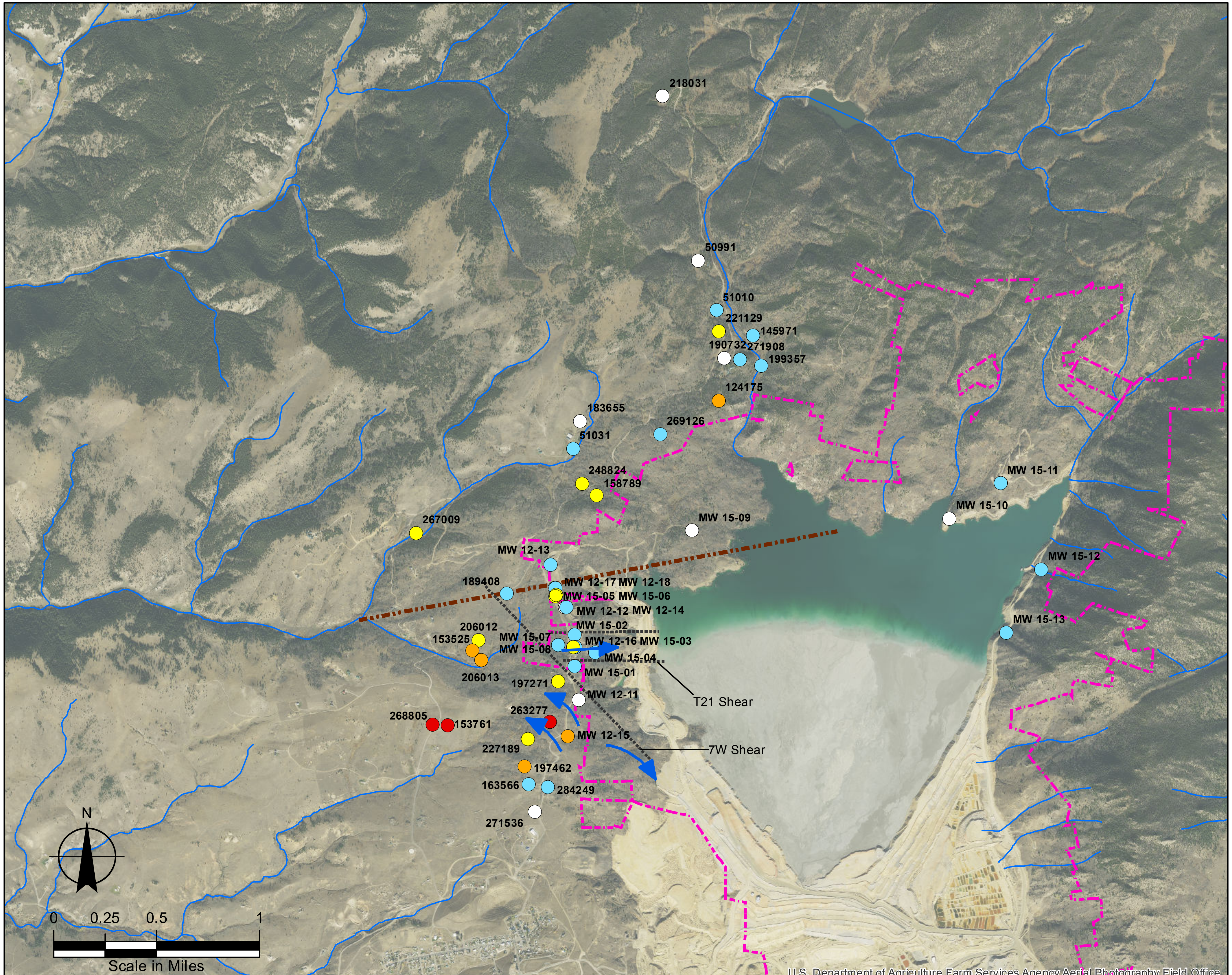
HYDROLOGIC EVALUATION OF THE
YANKEE DOODLE TAILINGS IMPOUNDMENT
WEST RIDGE AREA
SILVER BOW COUNTY, MONTANA

AVERAGE SILICA CONCENTRATIONS IN WEST RIDGE AREA GROUNDWATER

FIGURE

4-12



LEGEND

Inferred Groundwater Flow Direction

Average Strontium Concentration (mg/L)

- < 0.15 (11)
- 0.15 - 0.30 (20)
- 0.30 - 0.50 (10)
- 0.50 - 0.75 (5)
- > 0.75 (3)
- Lineament 1
- Shear Zone
- Mine Poperty Boundary

NOTES:

Numbers in parentheses indicate number of wells with concentrations in the indicated range.

Average concentrations from 2012-2016 Monitoring Programs.

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HYDROLOGIC EVALUATION OF THE
YANKEE DOODLE TAILINGS IMPOUNDMENT
WEST RIDGE AREA
SILVER BOW COUNTY, MONTANA

AVERAGE STRONTIUM CONCENTRATIONS IN WEST RIDGE AREA GROUNDWATER

FIGURE

4-13

on the south side of the shear. The concentration trends south of the shear, best represented by MW12-15, extend northwestward to several residential wells located on the west side of the 7W shear. These trends are consistent with the 7W shear acting as a restriction to flow from the south ridge towards the potentiometric low, diverting flow to the northwest.

The 7W shear also influences groundwater flow in the vicinity of the potentiometric low. Figure 4-14 shows a schematic cross section through the potentiometric low at MW12-16, from the 7W shear on the west to the YDTI on the east. The figure shows that groundwater levels along this line are highest at wells MW15-07 and 15-08, west of Moulton Reservoir Road and decline steadily to the east. The higher groundwater levels west of the topographic high suggest that the 7W Shear restricts westward groundwater flow resulting in the groundwater divide being offset from the topographic divide.

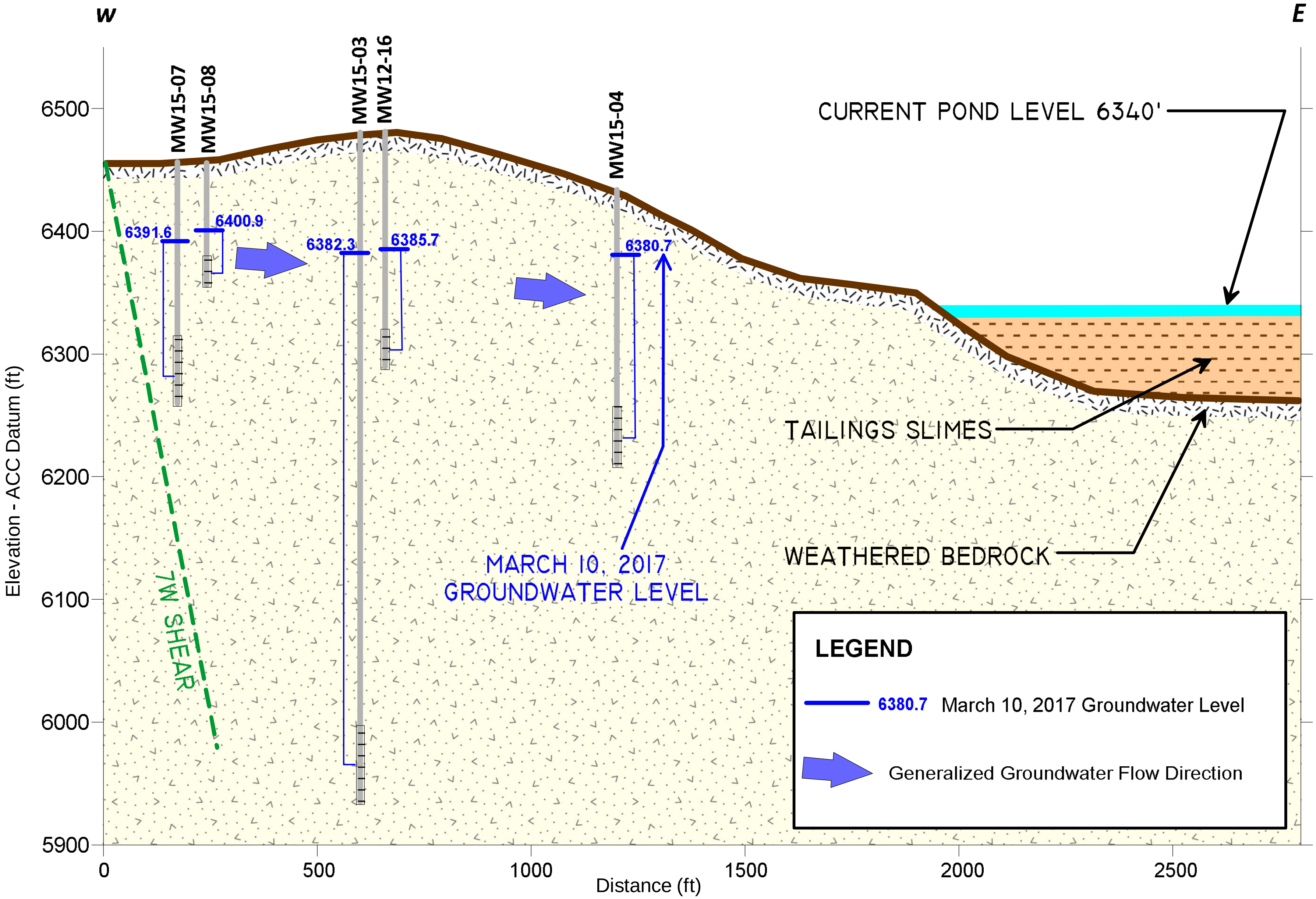
4.4.2 Deep Isolated Fracture System

4.4.2.1 Fracture System Geometry

As noted in Section 4.3.1, the deep isolated fracture system is bounded on the north, south and west by low permeability geologic structures or shear zones (Figures 4-7, 4-8, and 4-9). In the vicinity of monitoring well MW16-01 near the top of the West Ridge, the fracture system is approximately 500 feet wide between the north and south bounding structures (Figure 4-8). Information obtained through the drilling program and long-term pumping test indicates that the upper boundary of the fracture system (the 3W Shear) is about 470 feet bgs (elevation 6030) at MW16-01 and the fracture system extends to at least 640 feet bgs (elevation 5960), the total depth of drillhole DH15-14. Although the increased fracture density extends to at least 5960 feet, both the core log and the long-term pumping test results indicate the most highly fractured, higher permeability portion of the fracture zone is restricted to approximate elevation 6030 to 5930 feet (470 to 570 feet bgs) near the ridge crest.

The vertical extent of the deep isolated fracture system and higher permeability interval is inferred from the long-term pumping test results and the DH15-14 core log. As discussed in Section 3.5.5, water level responses were recorded at both VWP1 and VWP2 in DH15-14 and at monitoring well MW16-01. The hydraulic conductivity value estimated from DH15-14/VWP1 data however, located at elevation 5872 feet, is approximately an order of magnitude lower than that estimated from DH15-14/VWP2 at 6010 feet and MW16-01 completed from 5983 to 6015 feet. Therefore, the pumping test results indicate a decrease in hydraulic conductivity with depth in the fracture system. Information from the DH15-14 bedrock core (KP, 2017a) also reveals variability in bedrock fracture density with depth. Table 4-2 includes average RQD[2] values recorded from the DH15-14 bedrock core between elevation 6122, representing competent bedrock approximately 100 feet above the top of the fracture, to the total drillhole depth of 5860 feet. Average RQD values are highest in the competent bedrock above and immediately below the 3W Shear Zone, 84% and 93% respectively,

[2] Rock Quality Designation – Ratio of length of solid core pieces greater than 100 mm to length of total core run.



HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA SILVER BOW COUNTY, MONTANA	**SCHEMATIC EAST-WEST CROSS SECTION THROUGH POTENTIOMETRIC LOW**	**FIGURE** **4-14**

K:/PROJECT/12020/Amendment 10 Application/Surfer/Fig4-14_W-EXsec_PotLow.srf and lowest from elevation 5972 to 6024 (12%), representing the most highly fractured, higher permeability zone. RQD values then increase with depth up to 53% below 5972 feet. Thus, the bedrock core data and the pumping test data provide consistent information regarding vertical trends in the deep isolated fracture system permeability and a zone of increased fracturing and permeability from about elevation 6030 to 5930.

Drillhole DH16-01 provides information on the deep isolated fracture system characteristics east of the West Ridge towards the YDTI. DH16-01 VWP1, VWP2, and VWP3 all showed a direct but lower magnitude response to the long-term pumping test. Based on the depths of these VWPs and the core log, the fracture system at DH16-01 extends from about 275 feet bgs (elevation 6118), coinciding with the bottom of a significant shear zone (interpreted as the upper bounding 3W Shear), to about 375 feet bgs (elevation 6018) where VWP1 is located. The DH16-01 core log identifies a highly fractured zone from 282 to 297 feet bgs (elevation 6097 to 6112), and slightly fractured to competent bedrock from 297 to the drillhole total depth of 402 feet. This information indicates a thinning of the deep isolated fracture system from DH15-14 on the west to DH16-01 on the east. Water level drawdown in response to the long-term pumping test was about 5 feet at the DH16-01 VWPs, located 850 feet east of the pumping well, while drawdown at MW16-01 located 250 feet west of the pumping well was about 160 feet. The lower drawdown at DH16-01 suggests a decrease in fracture density and/or interconnectivity between the top of the West Ridge and the YDTI.

TABLE 4-2. AVERAGE BEDROCK RQD VALUES FROM DH15-14 BEDROCK CORE

Downhole Depth – feet	Elevation feet ACC	Formation	RQD
405-472	6122-6062	Competent Bedrock	84%
472-498	6062-6039	Shear Zone (3W Shear)	24%
498-515	6039-6024	Competent Bedrock	93%
515-577	6024-5972	High Fracture Zone	12%
577-609	5972-5940	Fracture Zone	33%
609-700	5940-5860	Fracture Zone	53%

Figure 4-15 shows the lateral and vertical extent of the deep isolated fracture system and the more highly fractured interval based on information from the West Ridge drilling and aquifer testing program. As noted above and in Section 4.3.1, the fracture system is bounded to the north, south, west and top by low permeability geologic structures. Although fracturing extends to the total depths of drilling near and east of the West Ridge crest, the degree of fracturing and hydraulic conductivities decrease with depth and to the east resulting in decreased bedrock permeability in these directions.

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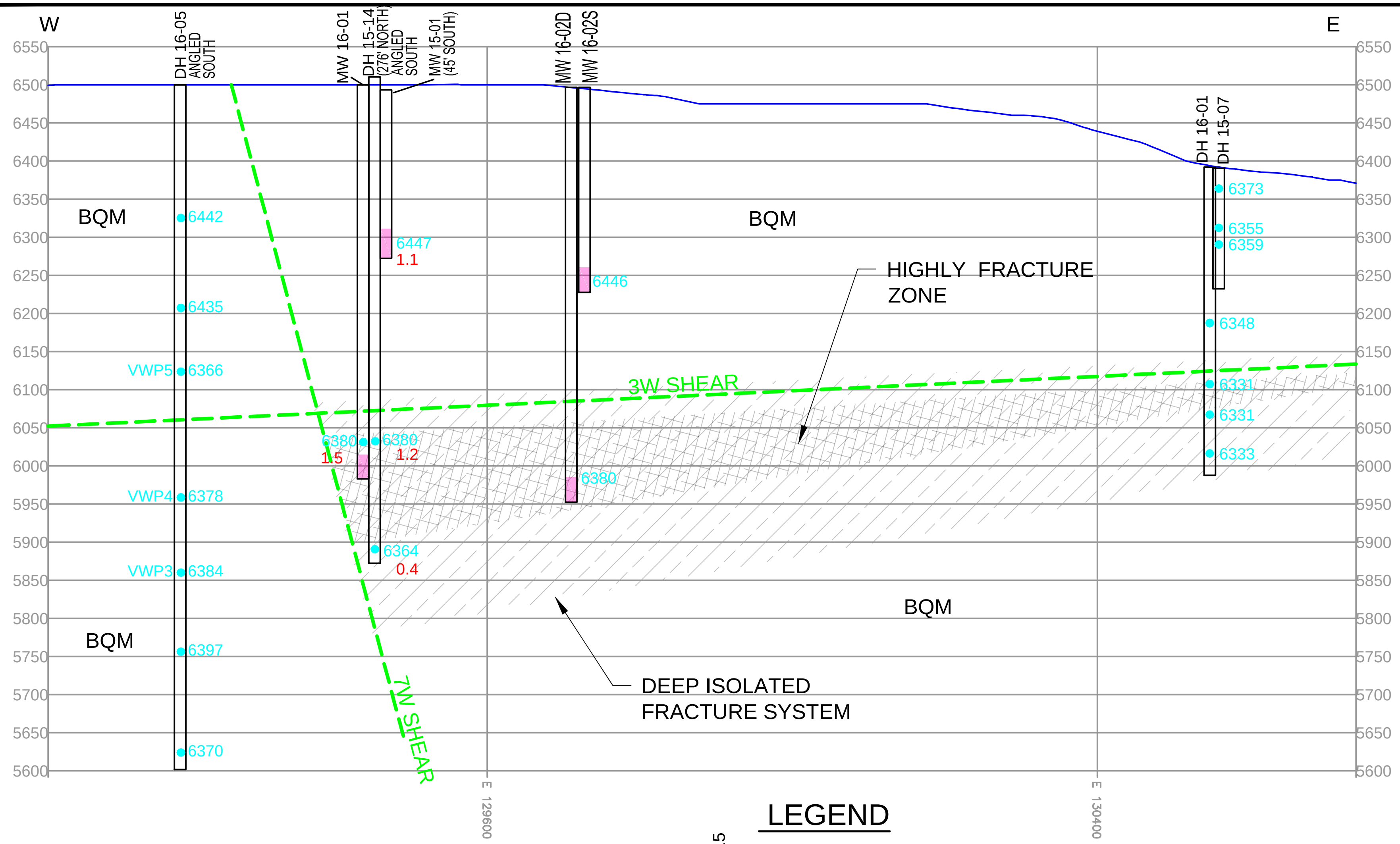

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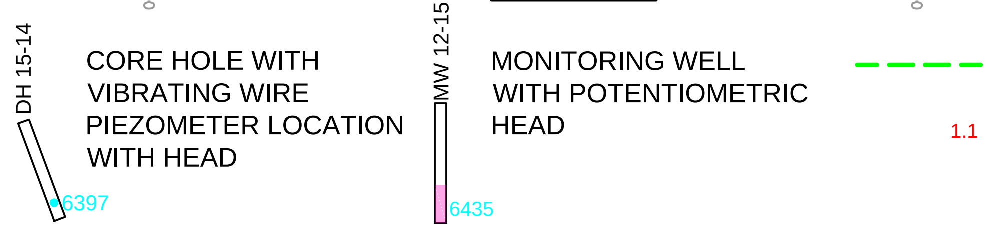

CORE HOLE WITH VIBRATING WIRE PIEZOMETER LOCATION WITH HEAD

MONITORING WELL WITH POTENTIOMETRIC HEAD

SHEAR ZONE

HYDRAULIC CONDUCTIVITY FEET/DAY

SCALE
(In Feet)
0 200

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HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA

DEEP ISOLATED FRACTURE SYSTEM BOUNDARIES AND POTENTIOMETRIC HEADS FOR JUNE, 2017

FIGURE
4-15

4.4.2.2 Fracture System Hydraulic Heads

Current hydraulic heads within the deep isolated fracture system are shown in Figure 4-15. Current heads in fracture system monitoring wells MW16-01 and MW16-02D are approximately 6380 feet. Hydraulic heads in the DH15-14 VWPs as of 6/22/17 include 6363 feet at deeper VWP1 and 6380 at VWP2. As of late June 2017, hydraulic heads near the West Ridge crest continue to increase at about 0.03 ft/day. Hydraulic heads at DH16-01 to the east are lower than those near the ridge crest with heads ranging from 6331 to 6333 feet in the three VWPs (Figure 4-15).

Water levels in the overlying bedrock are higher than the fracture system heads with water elevations in bedrock monitoring wells MW15-01 and MW16-02S about 6446 feet, 66 feet higher than the underlying fracture system heads. As noted in Section 3.5.5, some leakage does occur through the one or more of the low permeability shear zones which bound the fracture system to the north, south and top. Based on this recharge mechanism, and hydraulic heads in the surrounding bedrock, the fracture system heads in MW16-01 and MW16-02D are expected to continue to increase until an equilibrium condition is attained with the surrounding bedrock.

4.4.2.3 Fracture System Hydraulic Properties

Results of the long-term pumping test conducted on the deep isolated fracture system (Section 3.5.5) show a fracture system hydraulic conductivity near the West Ridge crest of approximately 1.2 to 1.5 ft/day ($4.1*10^{-6}$ to $5.3*10^{-6}$ m/sec) in the more highly fractured and permeable vertical interval (5930 to 6030 foot elevation). These values are up to an order of magnitude higher than the surrounding bedrock. As expected, the hydraulic conductivity is lower in the deeper less fractured zone, with an estimated hydraulic conductivity of 0.4 ft/day ($1.4*10^{-6}$ m/sec) based on pumping test data from DH15-14 VWP1 at approximate elevation 5872. Although detailed analysis of the data was not possible due to background influences, the water level response at DH16-01 indicates that the bedrock permeability decreases eastward between the West Ridge crest and the YDTI.

4.4.2.4 Fracture System Groundwater Flow

As discussed above, hydraulic heads outside of the deep isolated fracture system are generally higher than those within the fracture system resulting in a positive hydraulic gradient towards the fracture system. Groundwater levels north of the fracture system (north of the T19/T21 Shears, Figure 4-8) are 5 to 10 feet higher than the fracture system heads, with water levels in the overlying bedrock (and above the 3W Shear) 60 to 70 feet higher than the fracture system heads. Both of these areas exhibited a delayed water level response to the long-term pumping test, indicating some low level hydrologic connection across the T19/T21 and 3W shears. Based on the hydrologic connection and hydraulic gradients, saturated bedrock north of and vertically above the deep isolated fracture system is a source of recharge to the fracture system.

West of the fracture system (and 7W Shear), groundwater levels as documented in drillhole DH16-05 are generally similar to or higher than those within the fracture system. Hydraulic heads at DH16-05 VWP2, VWP3, VWP4, VWP6, and VWP7 are all similar to or higher than the fracture system heads, with the head highest at uppermost VWP-7 (6442 feet). Heads at VWP1 and VWP-5 are both lower than the current fracture system heads (Figure 4-15). Although VWP5 was identified as exhibiting a potential delayed response to the long-term pumping test (Section 3.5.5), the considerable lag in the initial response after the start of the pumping test (13 days) compared to the lag time at other sites (i.e., 15 hours at MW15-01, Table 3-9), the location of VWP5 relative to the fracture zone and bounding structures, and higher groundwater levels below and east of the 7W Shear (6435 feet at MW15-01), suggest that the observed water level trends at VWP5 are not associated with the long term pumping test. Therefore, significant leakage into or out of the deep isolated fracture system through the west-bounding 7W Shear is not indicated by the current data.

Based on the distribution of hydraulic heads within and outside of the fracture system, recharge to the fracture system occurs as leakage through the north (T19/T21 Shears) and possibly the overlying (3W Shear) bounding structures. As previously noted, hydraulic heads within the fracture system are currently increasing more rapidly near the ridge crest as compared to the near steady hydraulic heads at DH16-01 to the east. These trends suggest that the fracture system recharge rates are highest near the West Ridge crest. Current water levels in these recharge areas are about 6385 feet north of the T19/T21 Shears, the area referred to as the bedrock groundwater potentiometric low, and 6446 feet in the saturated bedrock overlying the fracture system (note that leakage through the T19/T21 Shears is likely partially responsible for the occurrence of the groundwater potentiometric low). Groundwater elevations in these recharge areas will determine, in part, at what elevation the fracture system water levels equilibrate. As noted above, the fracture system may also receive recharge from the west through the 7W Shear, or from the south through the T19 Twin Shear, although information on leakage through these structures is less conclusive.

Hydraulic gradients within the fracture system are both vertically downward and eastward from the ridge crest (Figure 4-15). Based on the direct response to the long term pumping test (i.e., hydrologic connection) in both the downward and eastward directions, some component of flow occurs in both directions. Using the current water level data, hydraulic gradients in the vertically downward and eastward directions are approximately 0.12 and 0.05 respectively. This suggests, all else being equal, a stronger component of downward flow as compared to eastward flow. Assuming the bounding structures continue with depth, groundwater flow within the deep isolated fracture system would most likely be vertically downward from the primary recharge area near the West Ridge crest, with discharge to the completely weathered bedrock and/or Silver Bow Creek alluvium beneath or south of the YDTI.

4.5 HYDRODYNAMIC CONTAINMENT

The main basis of the West Embankment design as well as future operation and management of the YDTI is to ensure that the current state of hydrodynamic containment is maintained into the future, including at an ultimate tailings pond elevation of 6429. For purposes of this evaluation, hydrodynamic containment means that tailings water from the YDTI does not migrate west of the MR property boundary and West Ridge, and adversely affect offsite water quality. Currently, the hydraulic gradient throughout the West Ridge is eastward from the ridge crest toward the YDTI, precluding the potential for westward seepage through the ridge. Maintaining a positive hydraulic gradient from the ridge towards the impoundment has been identified as the most viable means of ensuring hydrodynamic containment under future YDTI conditions (KP, 2016).

The West Embankment design includes multiple measures to ensure future hydrodynamic containment including construction of the embankment itself. The West Embankment is intended to restrict the western extent of the YDTI and tailings, thereby reducing the potential for migration of tailings water beyond the West Ridge. Other components of the embankment design intended to ensure future hydrodynamic containment include the embankment construction materials, an upstream seepage collection drain (the West Embankment Drain or WED), a WED extraction basin, and two drain pods (KP, 2016). These design components are shown in the WED design drawings (Appendix D), reproduced from the WED design document (KP, 2016), and are described below.

West Embankment Construction Material

The West Embankment design includes two general material types; an upstream free draining zone (Zone U) and a downstream lower permeability zone (Zone D1) (KP, 2016). This sequencing of materials from the upstream to downstream sides of the embankment is intended to allow any seepage water from the impoundment into the embankment to drain vertically downward to the WED and prevent seepage through the embankment. As such, the embankment fill materials are designed to promote containment of the tailings water.

West Embankment Drain

The WED is intended to maintain piezometric heads along the west side of the YDTI below the West Ridge groundwater levels, thereby maintaining the current hydrologic divide west of the impoundment. The WED will extend along the upstream side of the West Embankment for the entire embankment length of about 6800 feet. The WED invert elevation will range from about 6351.5 on the north end to 6335.5 on the south with an overall grade of 0.25%. The WED drainage will gravity drain southward to an extraction pond where the collected water will be pumped back to the YDTI (Appendix D). The WED design includes a coarse drain rock central zone with drain material ranging in size from 3 inch to 24 inch. The drain rock will be enveloped in an engineered filter and transition zone comprised of earthen materials designed to ensure long-term functionality of the drain (KP, 2016). The WED has a designed maximum flow capacity of 4,500 gpm based on the maximum historic flows recorded at Horseshoe Bend. This design flow is considered to be conservative since a portion of seepage from the YDTI is expected to continue to occur through the East-West Embankment to the south and not report to the WED.

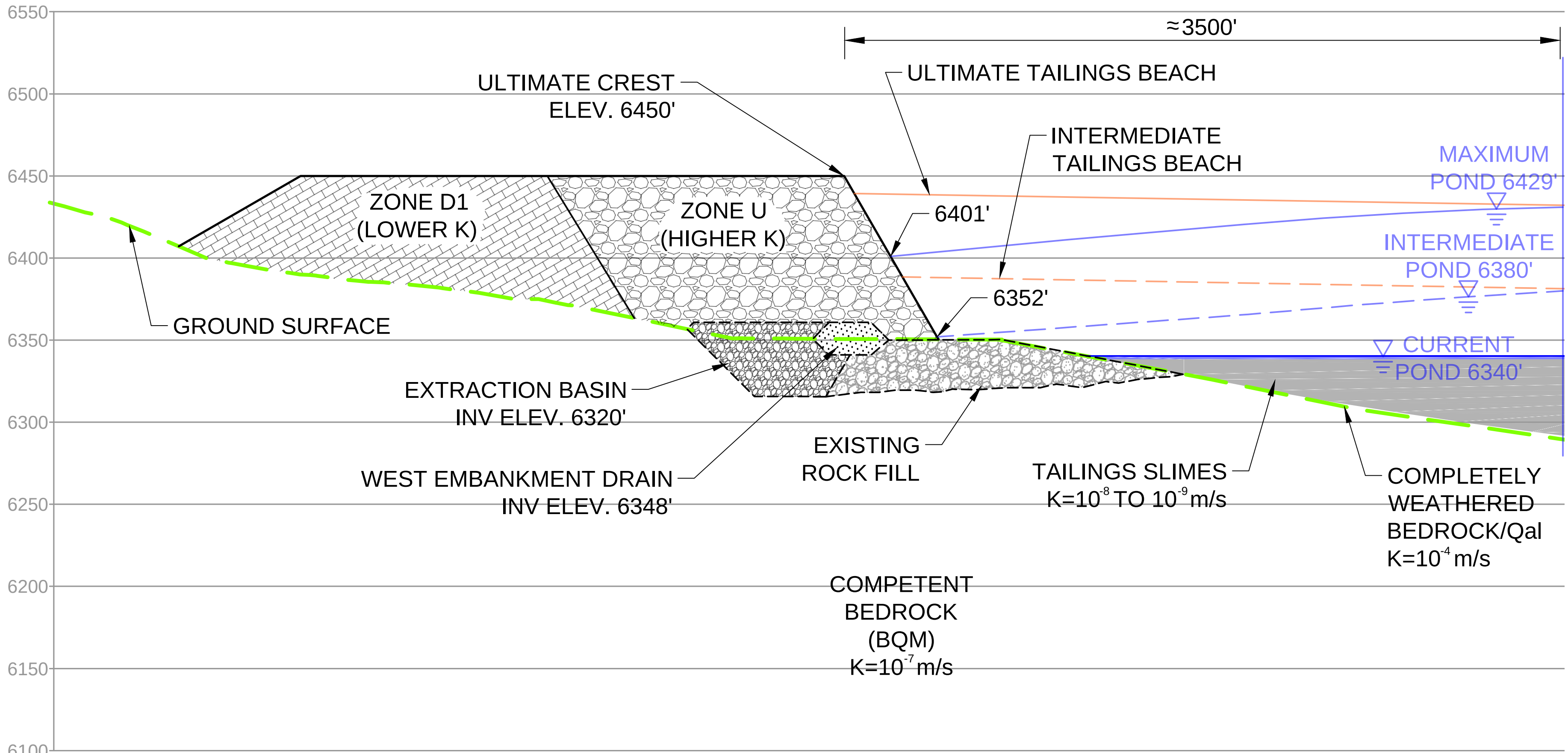
The WED is designed to maintain a positive hydraulic gradient from the West Ridge towards the West Embankment thereby ensuring long-term hydrodynamic containment. To achieve this, the WED design refers to groundwater elevations at the West Ridge potentiometric low as recorded in monitoring well MW12-16 (2016 range of 6379 to 6393 feet) as the critical point for controlling hydraulic heads at the upstream side of the embankment. This criterion provides a level of conservatism to the WED design. After the potentiometric low was discovered in 2012, an additional set of wells was completed to the west (MW15-07/15-08, Figure 3-2). This well pair was completed to determine if MW12-16 represented the lowest groundwater level not only in a north-south direction along the ridge, but also in an east-west direction. Groundwater elevations in well MW15-07, screened from 162 to 202 feet bgs, have ranged from about 6390 to 6403 feet or 10 feet higher than at MW12-16, with shallower well MW15-08 (screened from 81 to 101 feet bgs) even higher (6400 to 6420 feet). Therefore, use of the MW12-16 water levels as the critical point in the allowable hydraulic head in the WED design provides a level of conservatism to the WED design.

Extraction Basin

Other embankment design components aimed at ensuring long-term hydrodynamic containment include an extraction basin (Appendix D). The extraction basin is located due east of MW12-16 and the potentiometric low and is physically connected to the WED. The extraction basin will allow water to be pumped from the WED to the YDTI in the unlikely event that WED flows exceed the design flow capacity of 4,500 gpm. Besides providing this measure of safety, the presence of the extraction basin could be utilized to further reduce the potential for westward seepage from the YDTI if necessary. As shown in the WED design drawings (Appendix D), the extraction basin invert elevation (≈6320) is about 30 feet lower than the WED invert at that location, which may allow further lowering of the hydraulic head at the critical location through pumping from the extraction basin. Although not expected to be necessary, the extraction basin does provide additional means to ensure long-term hydrodynamic containment.

Figure 4-16 shows an east-west schematic cross section through the tailings impoundment and WED. The figure shows the relative positions of the WED and extraction basin, the free draining upstream Zone U, and the existing pond and tailings slimes. Also shown are the projected west tailings beach and pond at pond elevations of 6380 (the approximate groundwater level at the West Ridge potentiometric low and deep fracture system) and the ultimate 6429 level. Within the first five years of development, the west tailings beach is expected to extend approximately 3500 feet eastward from the West Embankment forcing the tailings pond 3500 feet away from the embankment (KP, 2017b). As noted in Section 4.2.3, the phreatic surface gradient through the existing tailings beach is approximately 0.008 ft/ft between SCPT15-02 and SCPT15-03 (Figure 4-5). Assuming a similar gradient develops through the west tailings beach, the decline in head through the 3500-foot beach between the pond to the West Embankment would be about 28 feet. This would result in a phreatic surface adjacent to the West Embankment at the ultimate pond elevation of about 6400 feet, not accounting for drawdown effects of the West Embankment and WED.

Also shown on Figure 4-16 is the 6380-foot tailings pond level and phreatic surface through the adjacent beach. Based on the projected 0.008 ft/ft gradient, the phreatic surface at the West Embankment would be about 6350 for the 6380 pond level (ignoring the WED effects), approximately 30 feet below current groundwater levels at the West Ridge potentiometric low and deep isolated fracture system. The Design Basis Report (KP, 2017b) indicates that the 6380 tailings pond level will not occur until 2023 or later. This means that six or more years of operational data can be collected and evaluated from the West Embankment and WED prior to the pond level reaching the limiting West Ridge groundwater levels to evaluate the operational performance and projected performance of the containment system under continued tailings placement. As previously noted, this analysis is based solely on the design pond and beach configurations and projected head loss through the tailings beach and does not account for the beneficial effects of the WED.



NOT TO SCALE

NOTES:

1. EMBANKMENT AND DRAIN DESIGN BASED ON KP, 2016.
2. PHREATIC SURFACE BETWEEN POND AND EMBANKMENT IGNORES EFFECTS OF WEST EMBANKMENT DRAIN.

HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA	**SCHEMATIC CROSS SECTION OF WEST EMBANKMENT AND DRAIN**	FIGURE **4-16**

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4.5.1 Flow Net Evaluation

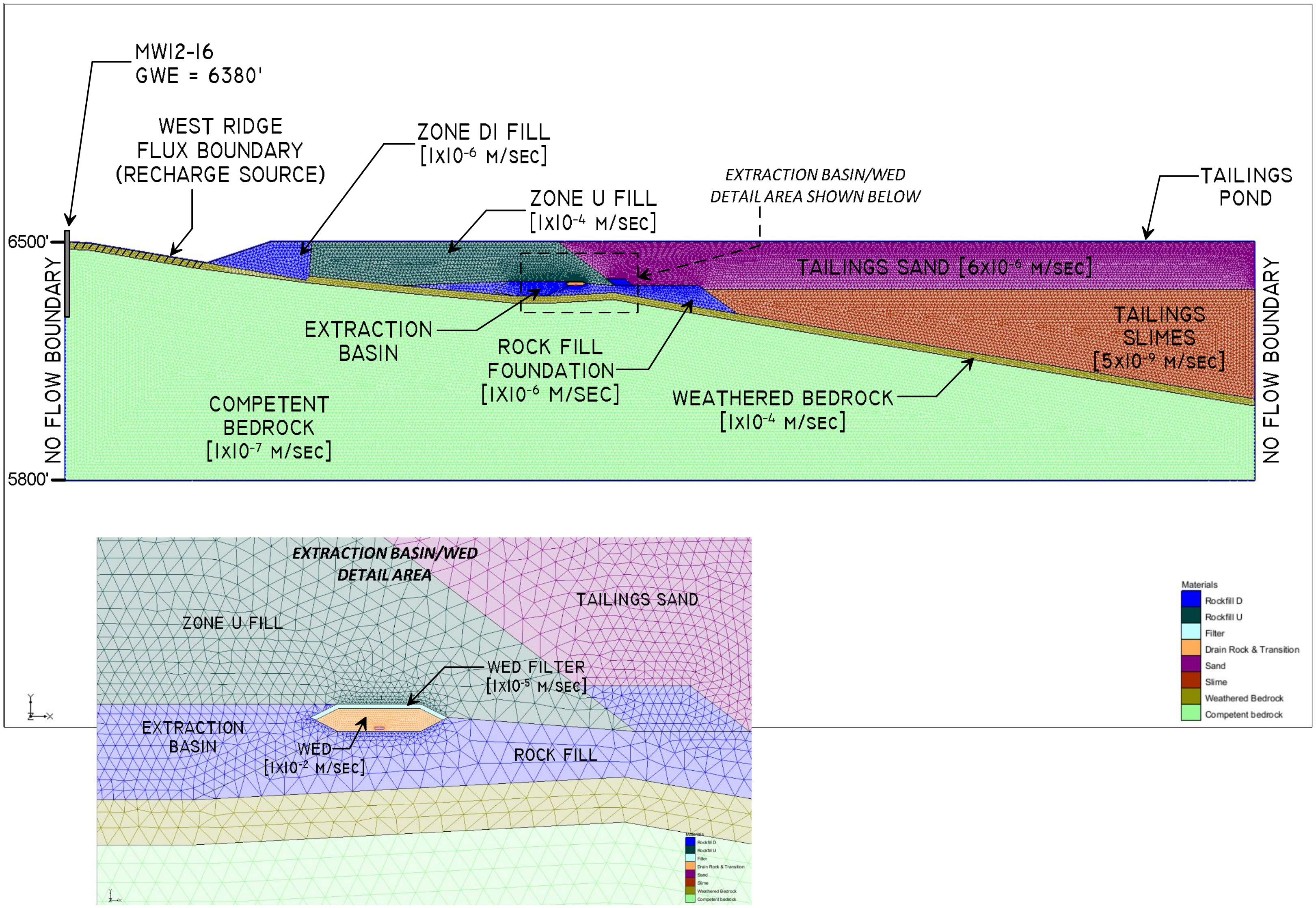
In order to evaluate the future performance of the West Embankment and WED design, a groundwater flow net analysis was performed to depict detailed groundwater flow patterns in the vicinity of the West Embankment and WED. A flow net is a graphical representation of two-dimensional steady state flow, comprised of two sets of orthogonal lines; lines of equal head (equipotential lines), and stream or flow lines. Typically the flow lines are spaced apart such that the flow rate or flux between each pair of adjacent flow lines is approximately equal revealing areas of greater or lesser flow. Flow nets were generated for three different scenarios: 1) current conditions with a pond elevation of 6340 feet and no WED; 2) a pond elevation of 6380 feet, the approximate elevation of the West Ridge groundwater potentiometric low; and 3) the maximum proposed pond level of 6429 feet. The last two scenarios included the West Embankment and WED as designed with a WED invert elevation of 6350 feet.

The flow nets were constructed along a cross section extending from the groundwater potentiometric low (MW12-16) near the West Ridge crest, eastward through the West Embankment to the center of the YDTI. The flow net cross sections correspond to the transect location shown in Figure 4-16 and include the future west tailings beach and eastern portion of the tailings pond for the 6380 and 6429 pond level scenarios. The flow nets were generated using the SEEP-2D finite element software package (Aquaveo, 2017). The model setup included incorporation of the various geologic and construction materials shown in Figure 4-16 including:

- Competent bedrock: the bulk unweathered BQM with a hydraulic conductivity of $1*10^{-7}$ m/sec;
- Weathered bedrock: the upper 20 feet of bedrock with a hydraulic conductivity of $1*10^{-4}$ m/sec;
- Tailings slimes with a hydraulic conductivity of $5*10^{-9}$ m/sec;
- Tailings sand with a horizontal hydraulic conductivity of $6*10^{-6}$ m/sec;
- Rockfill embankment foundation with a hydraulic conductivity of $1*10^{-6}$ m/sec;
- Zone U embankment fill with a hydraulic conductivity of $1*10^{-4}$ m/sec;
- Zone D embankment fill with a hydraulic conductivity of $1*10^{-6}$ m/sec;
- WED drain rock with a hydraulic conductivity of $1*10^{-2}$ m/sec; and
- WED drain filter material with a hydraulic conductivity of $1*10^{-5}$ m/sec.

All materials were treated as isotropic except for the tailings sands, which were assigned a K_H/K_V of 10.

The model domain extends from the West Ridge crest on the west, to near the center of the YDTI on the east, and includes a finite element mesh (Figure 4-17) with up to 30,000 nodes where hydraulic



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HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA SILVER BOW COUNTY, MONTANA	**SEEP-2D MODEL SETUP FOR WEST EMBANKMENT DRAIN FLOW NET GENERATION**	**FIGURE** **4-17**

heads are calculated. The western model boundary is represented as a no flow boundary depicting the West Ridge groundwater divide. Precipitation recharge was added to the West Ridge from the ridge crest (west edge of the model) eastward to the downstream (west) toe of the ultimate West Embankment, a distance of about 400 feet. The recharge rate was adjusted until the West Ridge phreatic surface matched the approximate measured groundwater elevation of 6380 feet at the location of the groundwater potentiometric low (MW12-16). The calibrated recharge rate is 0.3 ft^3/day (0.001 gpm), or about 20% of the annual precipitation rate of 15.9 inches over the recharge boundary area. The recharge rate represents lateral groundwater inflow from the north and south into the two dimensional model domain as well as incident precipitation recharge. The calibrated recharge rate was maintained in the projected 6380 and 6429 pond level simulations. The eastern boundary is simulated as a no flow boundary with constant head nodes added at the surface corresponding to the pond elevation and location for each scenario. The model extends from elevation 6500 feet at the top, corresponding to the West Ridge ground surface, to 5800 feet on the bottom, below the YDTI base.

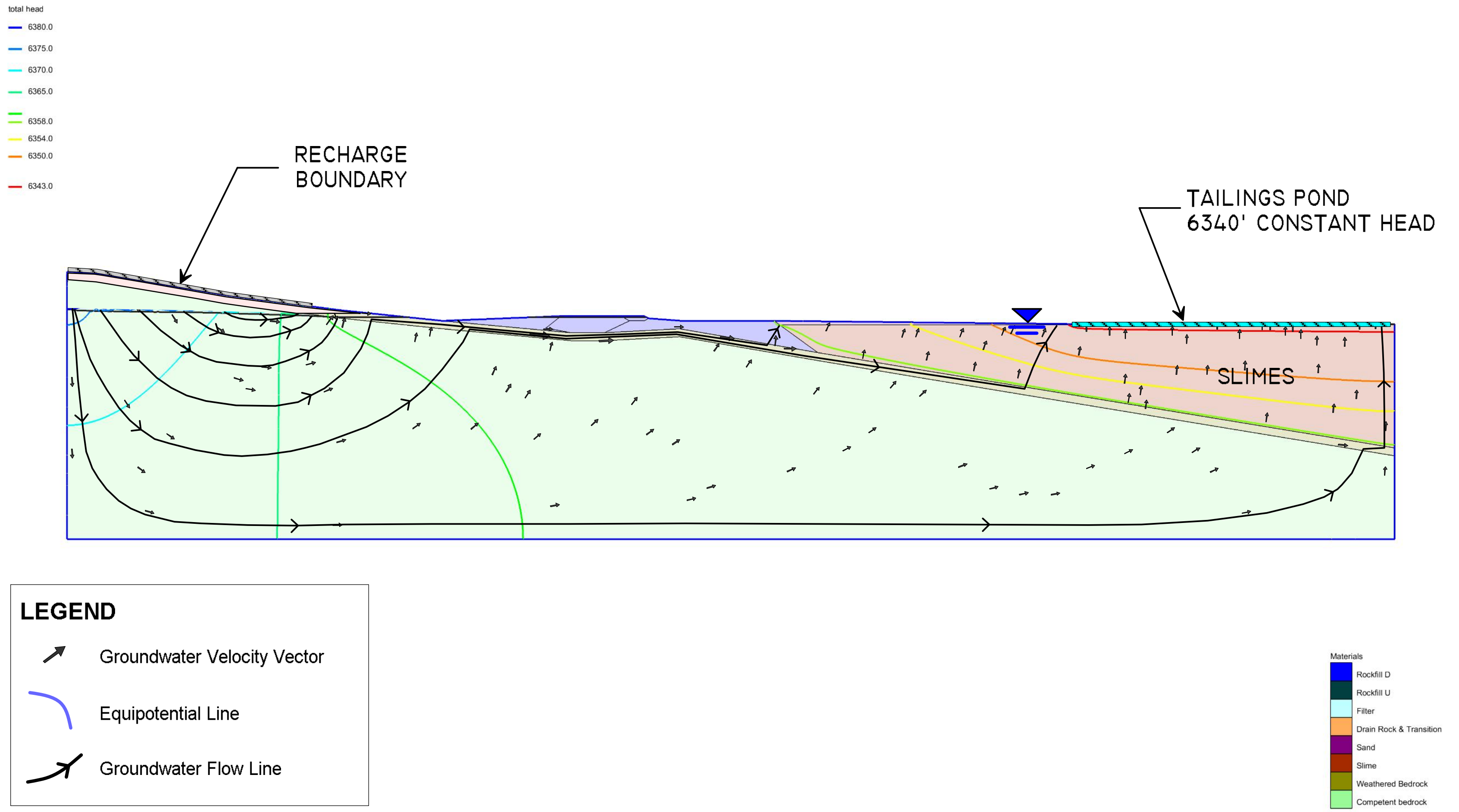
It should be stressed that the purpose of the SEEP-2D flow net analysis is to evaluate the groundwater flow field in the vicinity of the West Embankment/WED and east side of the West Ridge under future elevated tailings pond conditions. Due to certain limitations intrinsic to two-dimensional models simulating three-dimensional flow fields, the flow net analysis is not intended to be a quantitative representation of future groundwater flow for the YDTI. However, the simulation results do provide a good assessment of the anticipated performance of the WED at maintaining hydrodynamic containment, and the predicted conditions can be compared to future monitoring results to determine if the drainage system is generally performing as expected.

<u>6340 Pond Level (Current Condition)</u>

Figure 4-18 shows the groundwater flow net generated by SEEP-2D for the current YDTI scenario. The current scenario includes a West Ridge groundwater elevation of 6380 feet, a pond level of 6340 feet, and no WED drain. The flow net shows a west to east groundwater flow direction throughout the model domain as expected due to the highest groundwater elevations being in the West Ridge. As shown by the flow line distribution, the majority of flow through the competent bedrock occurs through the upper portion of the bedrock. The groundwater flow rate through the upper portion of the competent bedrock is approximately five times greater than the deeper bedrock flow rate as shown by the increase in flow line spacing with depth (Figure 4-18). Note that the flow-dependent flow line spacing shown for the competent bedrock on Figure 4-18 could not be shown for the weathered bedrock and sand (beach) units due to the greater flow rates and minimal thicknesses for these units. Although not included within the model domain, the majority of groundwater flow under this scenario is expected to flow eastward through the weathered bedrock layer beneath the tailings slimes, to the Yankee Doodle and Silver Bow Creek alluvium underlying the slimes further to the east. Overall, the 6340 pond level flow net closely resembles the conceptual model of current groundwater flow from the West Ridge.

<u>6380 Pond Level</u>

Figure 4-19 shows the model-generated flow net for a future scenario with a pond level of 6380 feet and a functioning WED. This scenario also includes a tailings beach along the full length of the West



LEGEND

Groundwater Velocity Vector

Equipotential Line

Groundwater Flow Line

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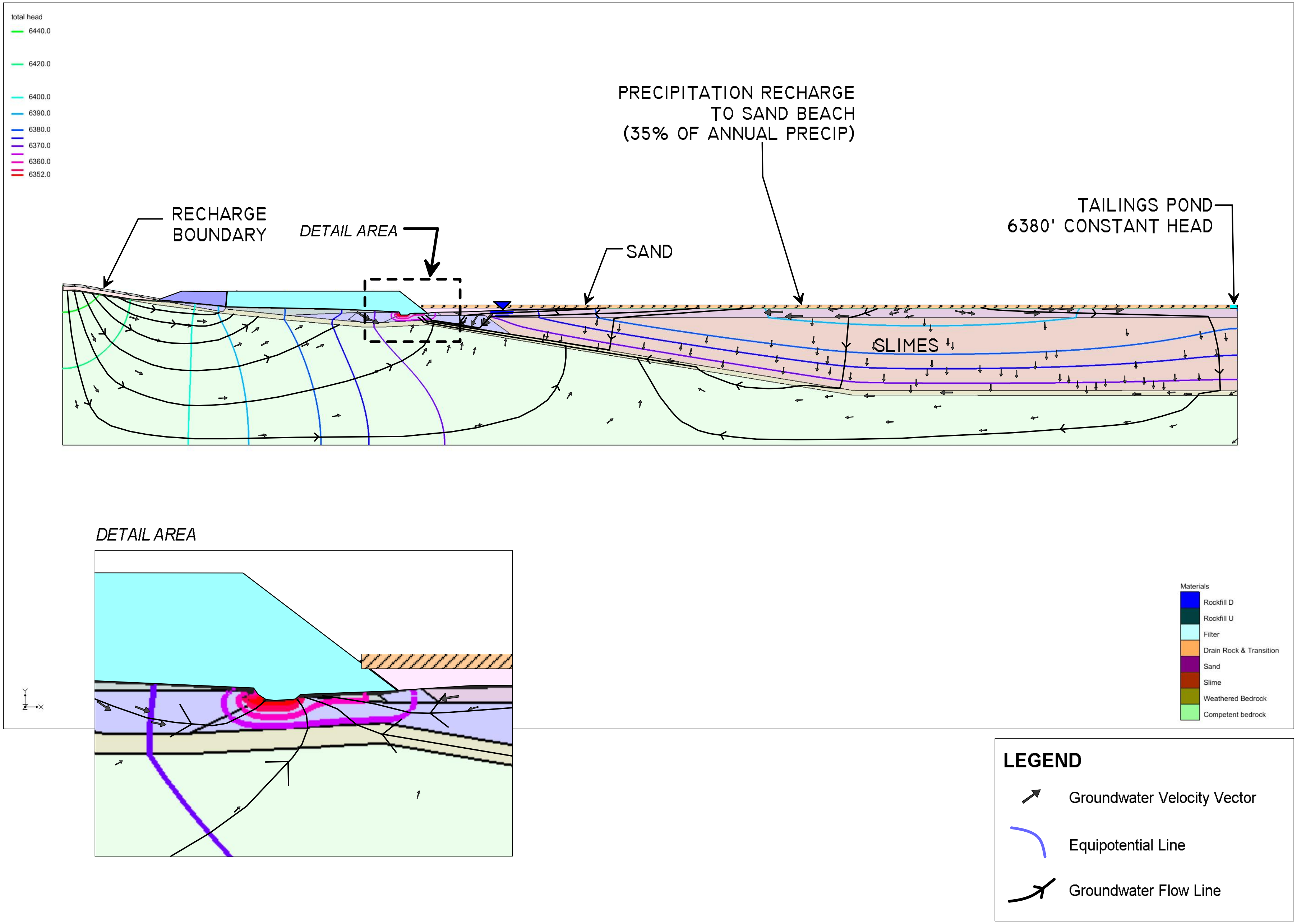
HYDROLOGIC EVALUATION OF THE
YANKEE DOODLE TAILINGS IMPOUNDMENT
WEST RIDGE AREA
SILVER BOW COUNTY, MONTANA

EXISTING CONFIGURATION
FLOW NET
POND LEVEL 6340' / NO WED

FIGURE

4-18



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HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA SILVER BOW COUNTY, MONTANA	**INTERMEDIATE CONFIGURATION FLOW NET POND LEVEL 6380' / WITH WED**	**FIGURE** **4-19**

Embankment extending 3,500 feet eastward from the embankment, with precipitation recharge (35% of 15.9 inch annual precipitation rate) through the sand beach. This simulation is intended to depict groundwater flow conditions with a pond level similar to the West Ridge groundwater potentiometric low and deep isolated fracture system, a condition expected to be reached around 2023.

The flow net shows all flow from the tailings pond and tailings reporting to the WED as intended. The phreatic surface at the WED is about 6350 feet, with a phreatic surface elevation of 6358 feet at the upstream face of the West Embankment. Similar to the 6340 flow net, the groundwater flow rate through the upper portion of the competent bedrock is approximately five times greater than the deeper bedrock flow rate as shown by the increase in flow line spacing with depth.

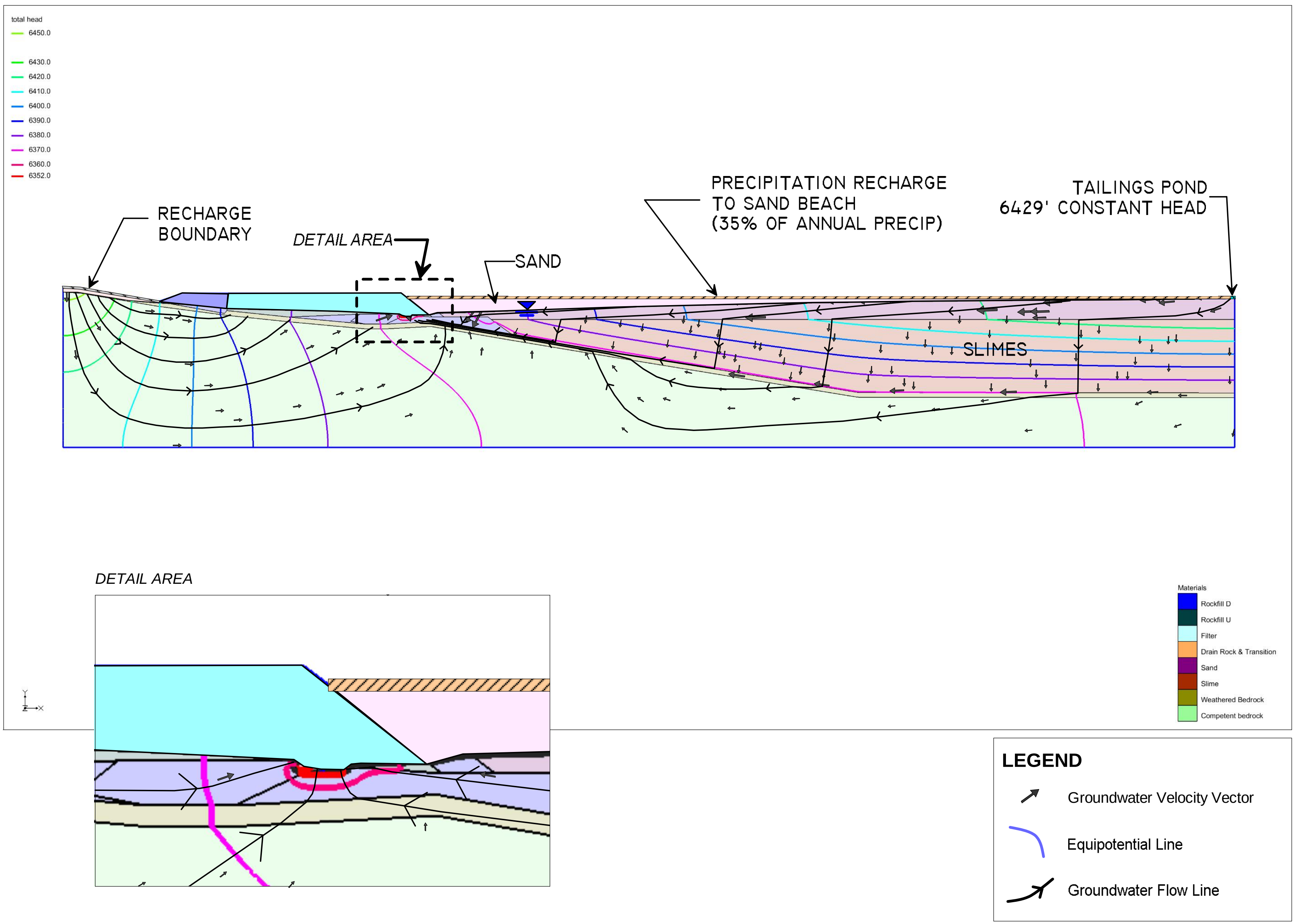
6429 Pond Level

Figure 4-20 shows the flow net for the maximum design pond level of 6429 feet. This scenario also includes the WED and 3,500-foot long West Embankment beach. The flow field under this scenario is similar to the 6380 pond level simulation with all flow from the pond and tailings reporting to the WED. The majority of seepage from the pond (87%) flows through the tailings beach sands with 13% flowing through the slimes. The elevation of the phreatic surface at the WED is about 6350 feet, and about 6360 feet at the upstream embankment face. The elevation of the phreatic surface at the WED is about 35 feet lower than the current West Ridge groundwater potentiometric low and 30 feet lower than the deep isolated fracture system head. The flow net-derived phreatic surface elevation at the upstream embankment face (6360) is about 40 feet lower than that estimated based on the hydraulic gradient through the beach sands alone (without the WED) as shown in Figure 4-16. This difference reflects the substantial effect on the phreatic surface anticipated from the WED and West Embankment.

In summary, the model-generated flow nets indicate that the WED will maintain hydraulic heads along the West Embankment below the critical groundwater level of 6380 at the West Ridge groundwater potentiometric low and the deep isolated fracture system. The depressed phreatic surface at the WED (6350 feet) and the upstream West Embankment face (6360 feet) at the ultimate pond level of 6429, should ensure long-term hydrodynamic containment along the West Ridge. As noted above, the tailings pond water level will not approach the groundwater level (6380 feet) at the West Ridge potentiometric low or deep isolated fracture system for six years, and water levels along the West Embankment are not expected to ever reach those levels based on the WED design and flow net analyses. In either case, operational monitoring of the YDTI over the next six or more years will allow for evaluation of the West Embankment and WED performance prior to embankment water levels approaching the critical West Ridge groundwater levels. The operational monitoring data can be compared to the model results to determine if the West Embankment/WED system is performing as intended.

4.6 CONCEPTUAL WATER MANAGEMENT/MITIGATION PLAN

As described in the previous section, the West Embankment and WED system are designed to ensure long-term hydrodynamic containment along the West Ridge. However, a contingency mitigation plan has been developed in the event that operational monitoring data indicates additional groundwater



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HYDROLOGIC EVALUATION OF THE
YANKEE DOODLE TAILINGS IMPOUNDMENT
WEST RIDGE AREA
SILVER BOW COUNTY, MONTANA

ULTIMATE CONDITION
FLOW NET
POND LEVEL 6429' / WITH WED

FIGURE
4-20

control measures are warranted. As noted in previous sections, the hydraulic head in the deep isolated fracture system is sensitive to small changes in recharge rates due to the bounding structures, confined conditions and low bedrock storativity. These properties make the fracture system amenable to manipulation of hydraulic heads and development of hydraulic barriers through recharge control. As such, the conceptual mitigation plan focuses on increasing heads within the deep isolated fracture system by augmenting natural recharge rates. Information obtained through the 2016 investigation program provides the basis for developing the conceptual plan.

4.6.1 Augmented Groundwater Recharge Test

In order to evaluate the potential for increasing heads within the fracture system though augmented recharge, an augmented recharge test was conducted in October 2016. The augmented recharge test was conducted from October 5th through 10th, 2016 and involved adding recharge water to monitoring well MW16-02D (completed in the deep isolated fracture system) and monitoring the water level response within the fracture system. At the time of the test, water levels in the deep isolated fracture system were about 6325 feet and recovering from the long-term pumping test at a rate of about one foot per day. Water was added to monitoring well MW16-02D by gravity draining from a 4,000 gallon tanker truck with the recharge water obtained from the Butte/Silver Bow municipal water system. Recharge test details are summarized in Table 4-3.

TABLE 4-3. AUGMENTED RECHARGE TEST DETAILS

Monitoring Site	MW16-02D (recharge well)	MW16-01	DH15-14 VWP1	DH15-14 VWP2	DH16-01 VWP1	DH16-01 VWP2	DH16-01 VWP3
Screen Interval/Depth	489-549	485-517	611	471	374	323	283
Distance from Recharge Well	0	255 West	240 West	230 West	825 East	825 East	825 East
Water Level Response	+95	+40	+35	+25	+2.5	+1.0	+0.8

NOTES:
Augmented recharge test performed 10/5 to 10/10/16.
Total 19,935 gallons added to MW16-02D; average recharge rate 2.3 gpm.
VWP - Vibrating Wire Piezometer
All measurements in feet.

A total of 19,935 gallons was added to MW16-02D for an average recharge rate of 2.3 gpm during the 5-day augmented recharge test. Besides the recharge well, water level responses were recorded in monitoring well MW16-01, VWP1 and VWP2 in DH15-14, and VWP1, VWP2, and VWP3 in DH16-01, all sites that showed direct responses to the deep isolated fracture system long-term pumping test. Observed water level increases west of the recharge well (after correction for background trends) ranged from a maximum of about 50 feet at MW16-01 to 35 and 25 feet, respectively, in VWP1 and VWP2 in DH15-14. Water level increases were lower at DH16-01, located 850 east of the recharge well, ranging from 0.8 to 2.5 feet in the three VWPs.

Following the recharge test, water levels continued to increase at the post-pumping test recovery rate. Figure 4-21 shows the water level trends in monitoring wells MW16-01 and MW16-02D (both completed in the deep isolated fracture system) from the beginning of the long-term pumping test through the augmented recharge test. As of March 15, 2017, the water level in these two deep monitoring wells was 6371 feet and increasing at about 0.15 ft/day. Based on the water level response at MW16-01 to the augmented recharge test, and post-test water level trends, the net recharge rate to the deep isolated fracture system was estimated (Figure 4-22). As shown in the figure, the post-test net recharge rate to the fracture system from the surrounding bedrock groundwater system is estimated to be on the order of one to two gpm. As noted, this is a net recharge rate meaning actual recharge would be greater than this by an amount equivalent to the fracture system discharge. However, based on the low groundwater flux rates through the fracture system indicated by the pumping and recharge tests, current recharge rates to the deep isolated fracture system are low while the fracture system water level continues to rise.

Based on the augmented recharge test results, augmented recharge appears to be a viable means of maintaining hydrodynamic containment along the West Ridge, if necessary. With current deep fracture system water levels at well MW16-02D of about 6380 and continuing to rise, and the 30 to 40-foot water level increases achieved at a distance of 250 feet from the injection well, with an injection rate of 2.3 gpm, increasing the water level across the entire approximately 500-foot width of the fracture system (as measured between the north and south bounding structures) would most likely be achievable with augmented recharge rates of a few gpm or less. Although the conceptual augmented recharge plan focuses on the deep isolated fracture system, the concept could be applied to the groundwater potentiometric low as well. Additional testing would be required to further assess the merits and details of a contingency augmented recharge program, if necessary. As noted in Section 4.5, YDTI water levels are not expected to approach those at the groundwater potentiometric low or in the deep isolated fracture system for a number of years (if ever), providing adequate time to evaluate the potential need for and details of an augmented recharge-based hydrodynamic containment strategy.

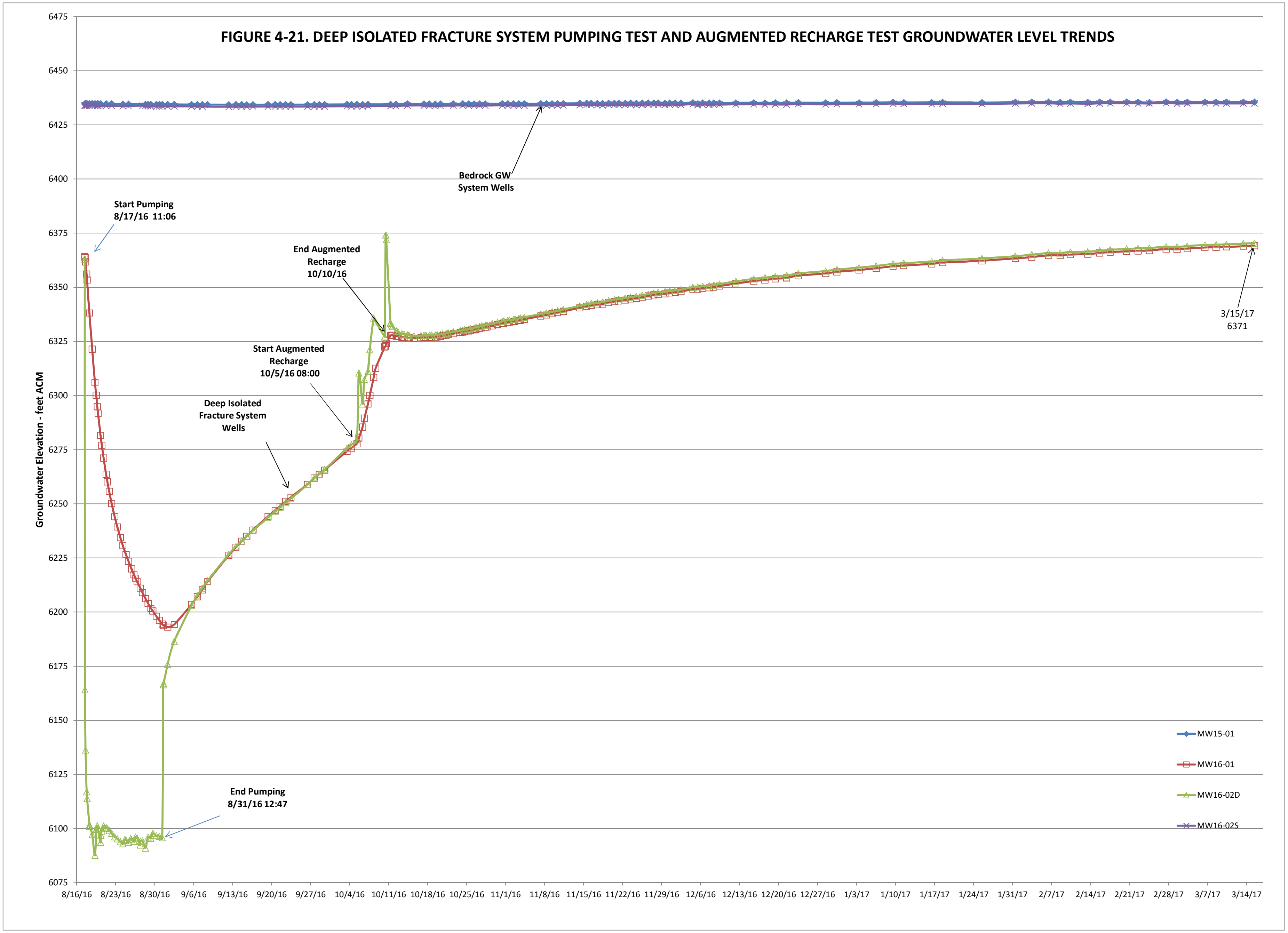

FIGURE 4-21. DEEP ISOLATED FRACTURE SYSTEM PUMPING TEST AND AUGMENTED RECHARGE TEST GROUNDWATER LEVEL TRENDS
Groundwater Elevation - feet ACM
Start Pumping 8/17/16 11:06
End Pumping 8/31/16 12:47
Bedrock GW System Wells
End Augmented Recharge 10/10/16
Start Augmented Recharge 10/5/16 08:00
Deep Isolated Fracture System Wells
3/15/17 6371
MW15-01
MW16-01
MW16-02D
MW16-02S
6475
6450
6425
6400
6375
6350
6325
6300
6275
6250
6225
6200
6175
6150
6125
6100
6075
8/16/16
8/23/16
8/30/16
9/6/16
9/13/16
9/20/16
9/27/16
10/4/16
10/11/16
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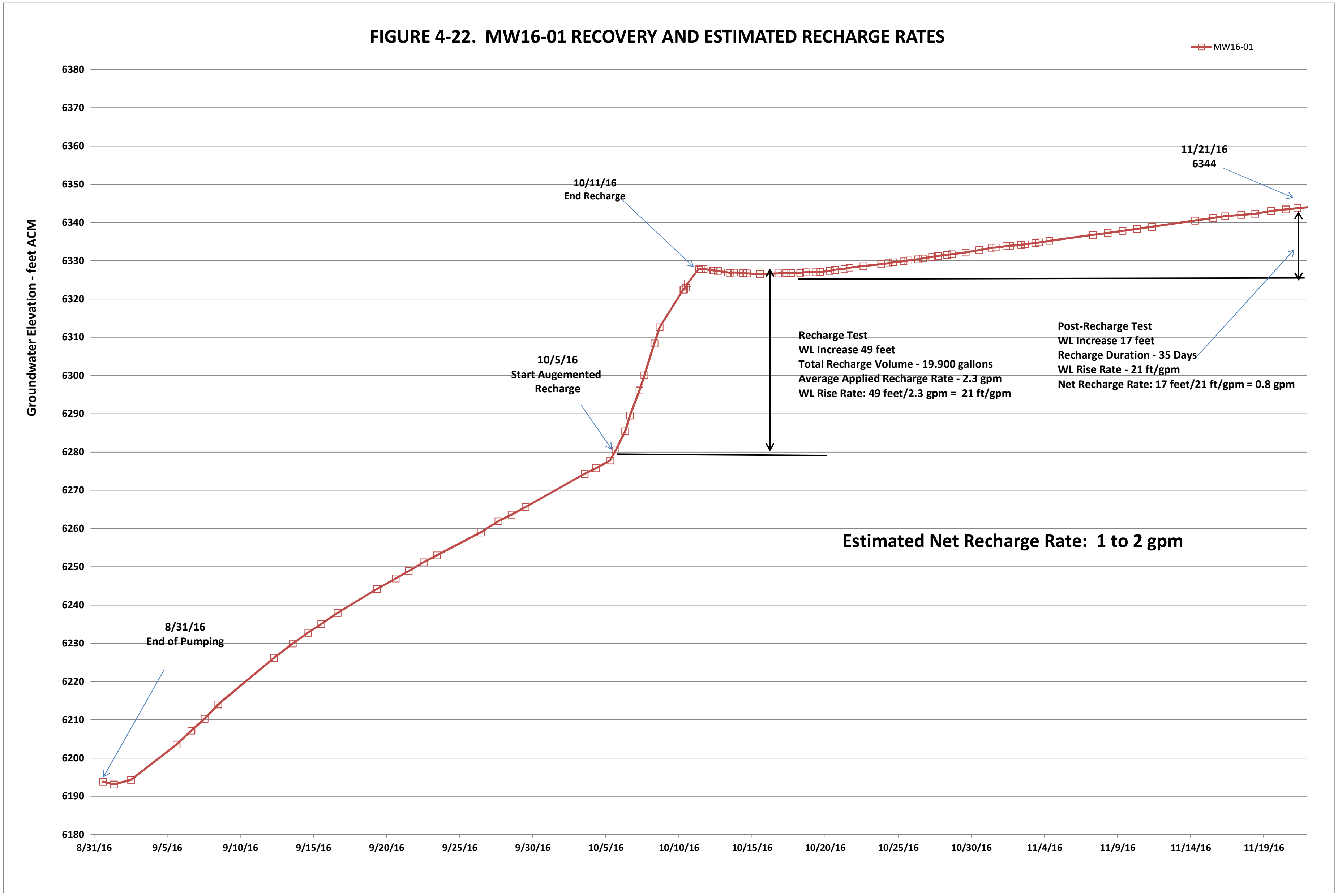

FIGURE 4-22. MW16-01 RECOVERY AND ESTIMATED RECHARGE RATES
MW16-01
Groundwater Elevation - feet ACM
6380
6370
6360
6350
6340
6330
6320
6310
6300
6290
6280
6270
6260
6250
6240
6230
6220
6210
6200
6190
6180
8/31/16
9/5/16
9/10/16
9/15/16
9/20/16
9/25/16
9/30/16
10/5/16
10/10/16
10/15/16
10/20/16
10/25/16
10/30/16
11/4/16
11/9/16
11/14/16
11/19/16
8/31/16
End of Pumping
10/5/16
Start Augemented
Recharge
10/11/16
End Recharge
11/21/16
6344
Recharge Test
WL Increase 49 feet
Total Recharge Volume - 19.900 gallons
Average Applied Recharge Rate - 2.3 gpm
WL Rise Rate: 49 feet/2.3 gpm = 21 ft/gpm
Post-Recharge Test
WL Increase 17 feet
Recharge Duration - 35 Days
WL Rise Rate - 21 ft/gpm
Net Recharge Rate: 17 feet/21 ft/gpm = 0.8 gpm
Estimated Net Recharge Rate: 1 to 2 gpm

5.0 SUMMARY AND CONCLUSIONS

MR has implemented an extensive hydrologic investigation and testing of the YDTI and surrounding area to evaluate the potential for uncontrolled seepage from the impoundment to the surrounding groundwater system under future impoundment conditions. Based on the investigation and testing results, steep hydraulic gradients and increasing groundwater elevations to the north and east of the impoundment minimize the potential for seepage of YDTI water in those directions. Seepage of impoundment water through the embankment to the south is controlled and treated at the Horseshoe Bend water treatment facility as part of the YDTI operational program. Based on current groundwater elevations within the West Ridge bedrock groundwater system however (6375 to 6480 feet), and a proposed ultimate tailings pond level of 6429 feet, the potential for uncontrolled seepage of impoundment water to the west without engineered and operational mitigation measures is recognized.

Extensive drilling and testing along the West Ridge shows the bedrock groundwater system to be of moderate to low hydraulic conductivity and behave as a double porosity fracture flow system. Numerous east-west trending geologic structures cross the West Ridge and, due to the accompanying mineral alteration and clay gouge, limit groundwater flow in a north-south direction. These low permeability shear zones divide the West Ridge into a number of semi-isolated bedrock blocks which are recharged primarily by incident precipitation and snowmelt recharge.

Two localized areas have been identified along the West Ridge where groundwater elevations are lower as compared to the rest of the ridge, and the potential for westward seepage exists barring any engineered and/or hydraulic controls. These two areas, referred to as the bedrock groundwater system potentiometric low and the deep isolated fracture system, are located in the central portion of the West Ridge where the ridge narrows and several east-west trending shear zones cross the ridge. Extensive drilling and testing in this area shows the deep isolated fracture system to be bounded to the north, south, west and top by low permeability shear zones, and the fracture system hydraulic conductivity to decrease to the east and with depth. Results of a 14-day pumping test confirm the limited lateral and vertical extent and indicate the groundwater flux rate through the fracture system is very low, on the order of a few gpm. Groundwater elevations in the fracture system near the ridge crest are currently about 6380 feet (at MW16-02D), slightly lower than those outside of the fracture system boundaries at the groundwater potentiometric low, currently about 6385 feet. The fracture system is recharge by limited leakage through the bounding structures, with leakage to the fracture system a contributing factor to the groundwater potentiometric low. Groundwater levels throughout the rest of the West Ridge reach elevations of more than 6480 feet.

The YDTI West Embankment design and operational plan includes a number of elements intended to ensure long-term hydrodynamic containment along the West Ridge, including at the critical groundwater potentiometric low and deep isolated fracture system locations. Based on a flow net analysis conducted with the SEEP-2D finite element modeling package, development of a tailings beach extending 3,500 feet eastward from the West Embankment, and inclusion of a free draining upstream face and West Embankment Drain system in the West Embankment design, will greatly reduce the phreatic surface elevation along the West Embankment. For example, under the ultimate proposed tailing pond elevation of 6429 feet, the phreatic surface is predicted to be about 6360 feet at the upstream side of the West Embankment and 6350 at the West Embankment Drain adjacent to the groundwater potentiometric low and deep isolated fracture system. Thus, the embankment design and operational plan is expected to maintain a positive hydraulic gradient between the West Ridge and the YDTI along the entire ridge length.

In addition to the multiple pumping tests performed, an augmented recharge test was conducted on the deep isolated fracture system to evaluate the fracture system response to the addition of water. The recharge test results show the fracture system head increased by more than 50 feet at a distance of 250 feet in response to the intermittent addition of 19,936 gallons of water over a five day period, or an average recharge rate of 2.3 gpm. The recharge test results show that augmented recharge, involving the addition of water to the deep isolated fracture system (or main bedrock groundwater system) at low rates can be an effective means of maintaining hydrodynamic containment at the critical groundwater potentiometric low and deep isolated fracture system locations. It should be emphasized however that current information and evaluation results suggest that such measures will not be necessary. Disregarding the head controlling effects of the west side tailings beach, the West Embankment and the West Embankment drain system, the actual tailings pond level is not forecast to reach the critical groundwater level of 6380 feet until 2023. This will allow adequate time to evaluate the performance of the West Embankment and drain system, and relative groundwater levels between the West Ridge and YDTI as the pond level increases, so that an appropriate mitigation plan can be implemented in the event that such measures are deemed necessary.

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APPENDIX A

MONITORING WELL COMPLETION LOGS

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MR 12-11

Date Hole Started: 7/31/2012 Date Hole Finished: 8/2/2012

Client: Montana Resources
Project: Montana Resources
County: Silver Bow State: Montana
Property Owner: Montana Resources
Legal Description: NW SE SEC36 T4N R8W
Location Description: West Ridge - Moulton Road

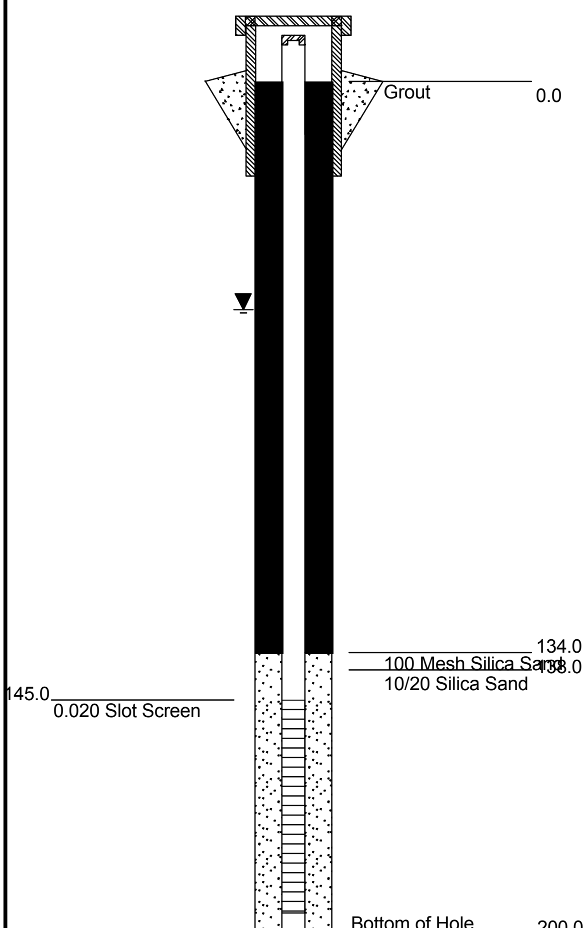
Recorded By: Larry Johnson
Drilling Company: O'Keefe
Driller: Mike Downy
Drilling Method: Rotary
Drilling Fluids Used: Air, Water
Purpose of Hole: Groundwater Monitoring
Target Aquifer: Bedrock
Hole Diameter (in): 8"
Total Depth Drilled (ft): 200

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	4-inch, flush threaded, Sch 40, PVC	+2 - 200
Surface Casing Used?	Y	8" Steel	+2.5 - 17.5
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	145 - 195
Sand Pack?	Y	#100 Silica Sand/10/20 Silica Sand	134-138, 138-200
Annular Seal?	Y	Gopher Grout	0 - 134
Surface Seal?	Y	Bentonite Chips	
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Air Lifting	
Water Samples Taken?	N		
Boring Samples Taken?	N		

Northing: 46.047139 Easting: 112.52995
Static Water Level Below MP: 55.5 Surface Casing Height (ft): 2.5
Date: 8/2/2012 Riser Height (ft): 2.0
MP Description: Top of PVC Ground Surface Elevation (ft): 6519.4
MP Height Above or Below Ground (ft): 2.0 MP Elevation (ft): 6521.41

Remarks: Groundwater encountered at 57 feet. Well completed with a 5 foot blank section from 195 to 200. 100 mesh silica sand placed from 134 to 138 feet to separate filter pack and grout. Vertical datum is ACM Datum. Horizontal coordinates are WGS84 latitude and longitude.

WELL CONSTRUCTION



SAMPLE NOTES | GRAPHICS

GEOLOGICAL DESCRIPTION

0.0 - 15.0' **Quartz Monzonite**
Drilling dry.

15.0 - 18.0' **Quartz Monzonite**
Olive green color.

18.0 - 40.0' **Quartz Monzonite**
Light gray.

40.0 - 50.0' **Quartz Monzonite**
Light brown color, weak FeOx, minor fractures.

50.0 - 55.0' **Quartz Monzonite**
Light brown color.

55.0 - 60.0' **Quartz Monzonite**
Driller notes bit drop from 55 to 57 feet.
Stopped advancing hole at 60 feet and waited 15 minutes, then air lifted, no measurable water.

60.0 - 71.0' **Quartz Monzonite**
Drilling dry, making dust, no water.

71.0 - 75.0' **Quartz Monzonite**
Softer drilling.

75.0 - 118.0' **Quartz Monzonite**
Light gray color.
Hole sat overnight at 100 feet, water level at approximately 70 feet the next morning. Airlift hole dry, but not making measurable water.

118.0 - 119.0' **Quartz Monzonite**
Softer drilling - bit drop.

119.0 - 140.0' **Quartz Monzonite**
No cuttings returned while drilling, damp cuttings bridging annulus?
At 140 feet, stop advancing hole, wait 15 minutes, air lift, no water.

140.0 - 165.0' **Quartz Monzonite**
No apparent fracturing.
At 145 feet, slug of wet cuttings came out, dried up with <5 minute air lift, no measurable water afer 5 minutes.
160 Feet. Stopped advancing hole at 160 feet and waited 15 minutes, then air lifted, no water. Continue drilling dry.
At 161 feet, slug of saturated butte quartz monzonite came out when drilling resumed, rapidly dried up.
At 165 feet, same as above.

165.0 - 180.0' **Quartz Monzonite**
Inject water to clear cuttings, let hole site for 15 minutes, air lift and hole dries up.

180.0 - 200.0' **Quartz Monzonite**
Total hole depth at 200 feet, let hole site overnight, water at 55 feet btc in morning.

Hydrometrics, Inc.

Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW 12-12

Date Hole Started: 8/8/2012   Date Hole Finished: 8/10/2012

Client: Montana Resources
Project: Montana Resources
County: Silver Bow   State: Montana
Property Owner: Montana Resources
Legal Description: NW SE SEC36 T4N R8W
Location Description: West Ridge - Moulton Road

Recorded By: Larry Johnson
Drilling Company: O'Keefe
Driller: Larry Gagnon
Drilling Method: Rotary
Drilling Fluids Used: Air, Water
Purpose of Hole: Groundwater Monitoring
Target Aquifer: Bedrock
Hole Diameter (in): 8"
Total Depth Drilled (ft): 200

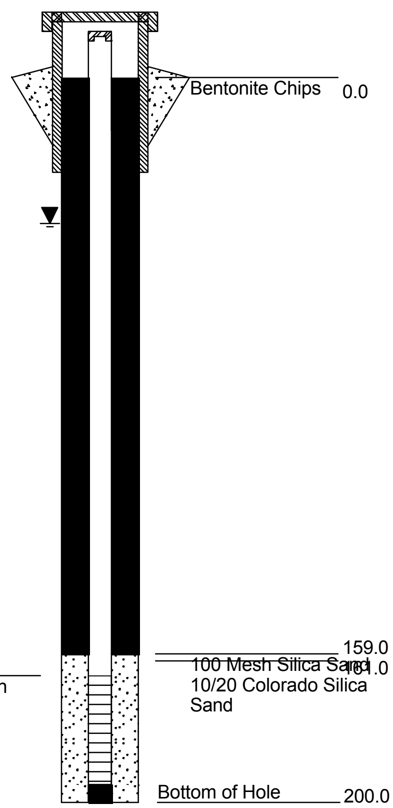
WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	4-inch, flush threaded, Sch 40, PVC	+2 - 195
Surface Casing Used?	Y	8" Steel	+2.5 - 38
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	165-195
Sand Pack?	Y	#100 Silica Sand/10/20 Silica Sand	159-161, 161-195
Annular Seal?	Y	Grout/Kwik Plug = 3/8" Chips	0-67, 67-159
Surface Seal?	Y	Bentonite Chips	
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Air Lifting	
Water Samples Taken?	N		
Boring Samples Taken?	N		

Northing: 46.053623   Easting: 112.531587
Static Water Level Below MP: 42.34   Surface Casing Height (ft): 2.5
Date: 8/22/2012   Riser Height (ft): 2.0
MP Description: Top of PVC   Ground Surface Elevation (ft): 6473.9
MP Height Above or Below Ground (ft): 2.0   MP Elevation (ft): 6475.87

Remarks: Gopher grout was implaced from top of sand to approximately 1.5 feet below ground surface. Five foot of blank added to bottom of completion for a sump. Vertical datum is ACM Datum. Horizontal coordinates are WGS84 latitude and longitude.

Well materials drilled out and replaced (June 4, 2013) per data above.

WELL CONSTRUCTION



SAMPLE NOTES | GRAPHICS

GEOLOGICAL DESCRIPTION

0.0 - 60.0' **Quartz Monzonite**
Hard drilling; Butte Quartz Monzonite.
At 45 feet, had to start injecting water - too much dust.
At 60 feet, stop advancing hole, let discharge dry up, wait 15 minutes and test for water by air lifting, no water.

60.0 - 82.0' **Quartz Monzonite**
Hard drilling; Butte Quartz Monzonite.
Soft drilling at 72 to 73 feet.
At 80 feet, stop advancing hole, wait 15 minutes and test for water by air lifting, no water.

82.0 - 92.0' **Quartz Monzonite**
Softer drilling, strong FeOx - in fractured zone.
At 92 feet, no FeOx - stop advancing hole and dry up hole with air, let sit for 15 minutes and test with air lift, not making any water.

92.0 - 112.5' **Quartz Monzonite**
Out of FeOx/fractures.
At 100 feet, stop advancing hole, let sit for 15 minutes, air lift, no water.

112.5 - 115.0' **Quartz Monzonite**
Strong FeOx - fracture zone.
At 112.5 feet, bit drops 0.5 feet.
At 115 feet, no FeOx - stop advancing hole and dry up hole with air, let sit for 15 minutes and test with air lift, not making any water.

115.0 - 138.0' **Quartz Monzonite**
No noticable FeOx/fracturing.
At 120 feet, stop advancing hole, let sit for 15 minutes, air lift <1 gpm.

138.0 - 145.0' **Quartz Monzonite**
Strong FeOx, stop advancing hole at 140, let hole sit for 15 minutes, air lift 1 - 2 gpm.

145.0 - 156.0' **Quartz Monzonite**
Out of fractured zone.

156.0 - 162.0' **Quartz Monzonite**
Weak FeOx - minor fracturing?
At 160 feet, stop advancing hole, wait 15 minutes, air lift 1 - 2 gpm.

162.0 - 200.0' **Quartz Monzonite**
No noticable FeOx/fracturing.
At 180 feet, stop advancing hole, wait 15 minutes, air lift 1 - 2 gpm, water level at 45 feet after sitting oversight at 180 feet.
Total hole depth at 200 feet, making 1 - 2 gpm.

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW 12-13

Date Hole Started: 8/3/2012 Date Hole Finished: 8/8/2012

Client: Montana Resources
Project: Montana Resources
County: Silver Bow State: Montana
Property Owner: Montana Resources
Legal Description: SE NE SEC36 T4N R8W
Location Description: West Ridge - Moulton Road

Recorded By: Larry Johnson
Drilling Company: O'Keefe
Driller: Dustin Timm
Drilling Method: Rotary
Drilling Fluids Used: Air, Water
Purpose of Hole: Groundwater Monitoring
Target Aquifer: Bedrock
Hole Diameter (in): 8"
Total Depth Drilled (ft): 200

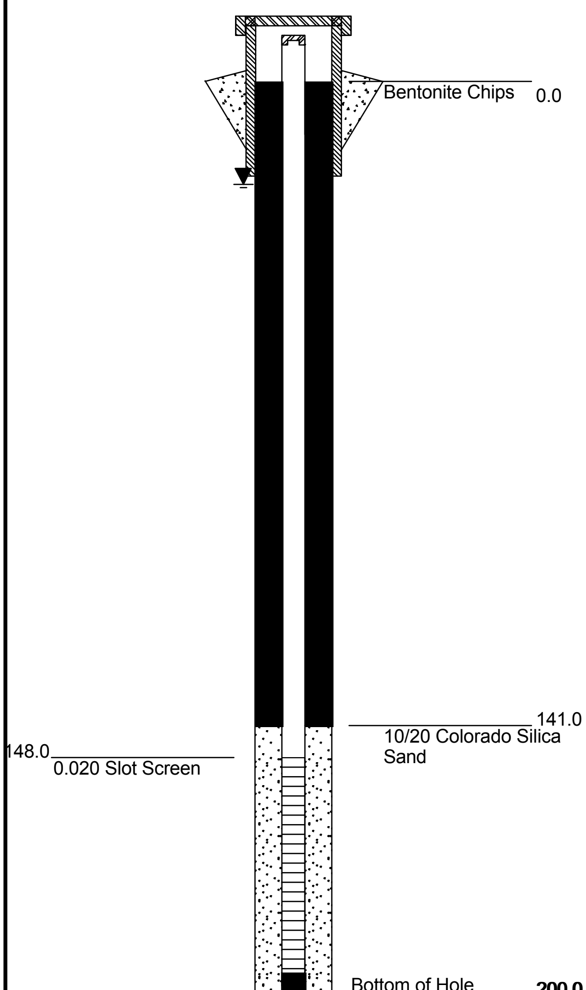
WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	4-inch, flush threaded, Sch 40, PVC	+2 - 198
Surface Casing Used?	Y	8" Steel	+2.5 - 17.5
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	148-198
Sand Pack?	Y	10/20 Silica Sand	141-198
Annular Seal?	Y	Kwik Plug = 3/8" Chips	0-141
Surface Seal?	Y	Bentonite Chips	
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Air Lifting	
Water Samples Taken?	N		
Boring Samples Taken?	N		

Northing: 46.056573 Easting: 112.533325
Static Water Level Below MP: 24.5 Surface Casing Height (ft): 2.5
Date: 8/17/2012 Riser Height (ft): 2.0
MP Description: Top of PVC Ground Surface Elevation (ft): 6488
MP Height Above or Below Ground (ft): 2.0 MP Elevation (ft): 6490.28

Remarks: Gopher grout was implaced from top of screen to approximately 1.5 feet below ground surface. Five foot of blank added to bottom of completion for a sump. Vertical datum is ACM Datum. Horizontal coordinates are WGS84 latitude and longitude.

Well materials drilled out and replaced (June 8, 2013) per data above.

WELL CONSTRUCTION	SAMPLE NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION



0.0 - 25.0' **Quartz Monzonite**
Drilling dry.
At 25 feet, olive green color, bigger chips.

25.0 - 33.0' **Quartz Monzonite**
Continued bigger chips, trace of white clay on fractures.

33.0 - 40.0' **Quartz Monzonite**
Smaller chips, light brown color, (FeOx) moist.
At 39 feet, light brown, no longer moist.
At 40 feet, stop advancing hole for 15 minutes, test for water by air lifting, no water.

40.0 - 60.0' **Quartz Monzonite**
Light gray butte quartz monzonite, no notable water.
At 60 feet, water level after setting over weekend - 18.3 feet.

60.0 - 76.0' **Quartz Monzonite**
Increased moisture at 60 to 75 feet. Drier at 75 to 76 feet.

76.0 - 85.0' **Quartz Monzonite**
Fresh butte quartz monzonite. Stop advancing hole, set for 15 minutes, test for water by air lifting, no water.
At 80 feet, stop advancing hole for 15 minutes, air lift, no water.

85.0 - 160.0' **Quartz Monzonite**
Softer drilling, no apparent clay or water.
At 100 feet, stop advancing hole, wait 15 minutes, air lift, no water.
At 120 feet, stop advancing hole, wait 45 minutes, air lift, minor water and quickly dries up.

160.0 - 192.0' **Quartz Monzonite**
Trace of FeOx, minor fracturing.
At 160 feet, water level at 49 feet after sitting overnight.
At 170 to 175 feet, softer drilling, fractures?
At 180 feet, air lifting 1 - 2 gpm.
At 182 feet, trace FeOx.
At 192 feet, trace FeOx.

192.0 - 200.0' **Quartz Monzonite**
No apparent fracturing. Total hole depth at 200 feet.

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW 12-14

Date Hole Started: 8/13/2012 Date Hole Finished: 8/16/2012

Client: Montana Resources
Project: Montana Resources
County: Silver Bow State: Montana
Property Owner: Montana Resources
Legal Description: SE NE SEC36 T4N R8W
Location Description: West Ridge - Moulton Road

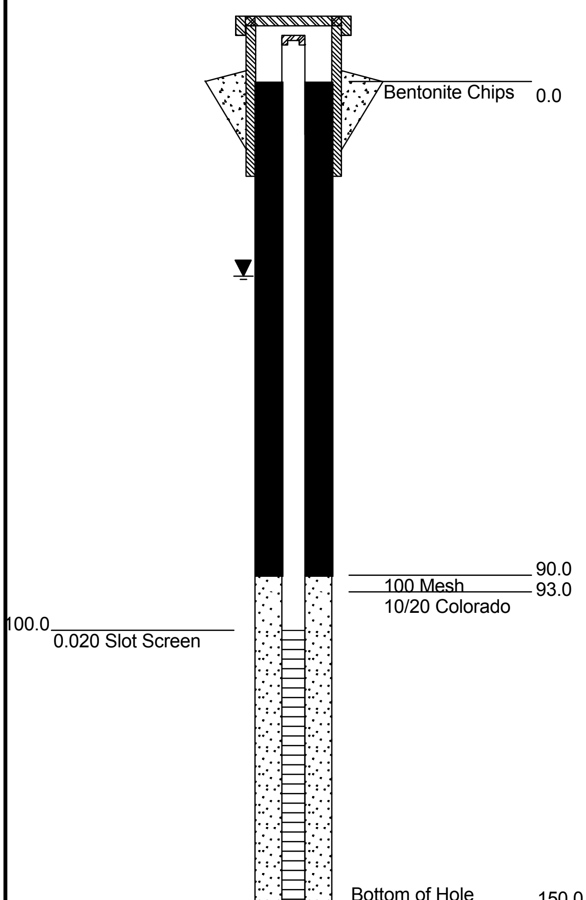
Recorded By: Larry Johnson
Drilling Company: O'Keefe
Driller: Dustin Timm
Drilling Method: Rotary
Drilling Fluids Used: Air, Water
Purpose of Hole: Groundwater Monitoring
Target Aquifer: Bedrock
Hole Diameter (in): 8"
Total Depth Drilled (ft): 150

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	4-inch, flush threaded, Sch 40, PVC	+2 - 150
Surface Casing Used?	Y	8" Steel	+2.5 - 17
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	100 - 150
Sand Pack?	Y	#100 Sand, 10/20 Silica Sand	90-93, 93-150
Annular Seal?	Y	Kwik Plug - 3/8" Chips, Grout	2-17, 0-90
Surface Seal?	Y	Bentonite Chips	
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Air Lifting	
Water Samples Taken?	N		
Boring Samples Taken?	N		

Northing: 46.053644 Easting: 112.531731
Static Water Level Below MP: 37.5 Surface Casing Height (ft): 2.5
Date: 8/22/2012 Riser Height (ft): 2.0
MP Description: Top of PVC Ground Surface Elevation (ft): 6474.5
MP Height Above or Below Ground (ft): 2.0 MP Elevation (ft): 6476.47

Remarks: 100 Mesh silica sand placed from 90 to 93 feet to separate grout from filter pack. First water approximately 55 feet. Vertical datum is ACM Datum. Horizontal coordinates are WGS84 latitude and longitude.

WELL CONSTRUCTION



SAMPLE NOTES | GRAPHICS

GEOLOGICAL DESCRIPTION

0.0 - 19.0' **Quartz Monzonite**
Weathered intrusive. Strong FeOx staining at 18 to 19 feet. Dry.

19.0 - 69.0' **Quartz Monzonite**
Hard drilling. No FeOx staining or evidence of fracturing. Dry to 50 feet then moist.
At 60 feet, stop advancing hole, wait 30 minutes, air lift <1 gpm.

69.0 - 75.0' **Quartz Monzonite**
Softer drilling, sparse FeOx staining.

75.0 - 105.0' **Quartz Monzonite**
Hard drilling. No FeOx staining.
At 80 feet, hole sets overnight. Water level at 38.5 next morning.
At 100 feet, air lift 15 minutes, making <1 gpm.

105.0 - 118.0' **Quartz Monzonite**
Softer drilling, trace FeOx staining.

118.0 - 124.0' **Quartz Monzonite**
Hard drilling. No FeOx staining.
At 120 feet, air lift for 15 minutes, making <1 gpm.

124.0 - 128.0' **Quartz Monzonite**
Softer drilling, weak FeOx staining.

128.0 - 136.0' **Quartz Monzonite**
Hard drilling. No FeOx.

136.0 - 138.0' **Quartz Monzonite**
Softer drilling.

138.0 - 145.0' **Quartz Monzonite**
Hard drilling intrusive.

145.0 - 150.0' **Quartz Monzonite**
Softer drilling, moderate FeOx.
Total hole depth at 150 feet.

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Stock Well

Hole Name: MW 12-15

Date Hole Started: 3/13/2013 Date Hole Finished: 3/15/2013

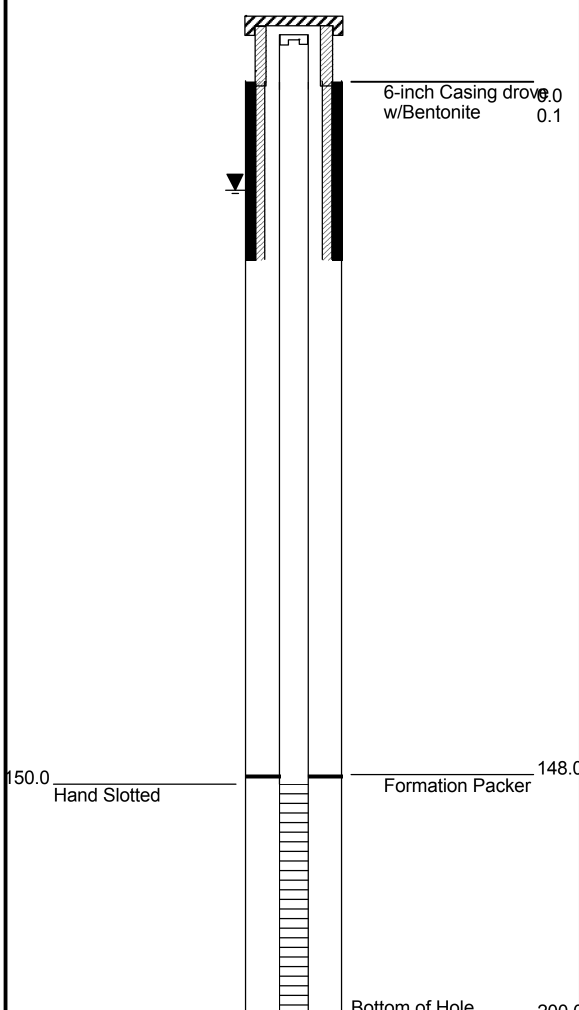
Client: Montana Resources
Project: Montana Resources
County: Silver Bow State: Montana
Property Owner: Mark and Shirley Rule
Legal Description: NW SE SEC36 T4N R8W
Location Description:
Recorded By: Larry Johnson
Drilling Company: O'Keefe
Driller: Larry Gagnon
Drilling Method: Rotary
Drilling Fluids Used: Air, Water
Purpose of Hole: Groundwater Monitoring
Target Aquifer: Bedrock
Hole Diameter (in): 6"
Total Depth Drilled (ft): 200

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	4-inch, flush threaded, Sch 40, PVC	+2 - 200
Surface Casing Used?	Y	6" Steel	+2.5 - 38
Screen/Perforations?	Y	Hand Slotted, Sch 40 PVC	150 - 200
Sand Pack?	N		
Annular Seal?	N		
Surface Seal?	Y	Bentonite Chips	
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Air Lifting	
Water Samples Taken?	N		
Boring Samples Taken?	N		

Northing: 46.044579 Easting: 112.530943
Static Water Level Below MP: 25.3 Surface Casing Height (ft): 2.0
Date: 3/20/2013 Riser Height (ft): 2.0
MP Description: Top of PVC Ground Surface Elevation (ft): 6517
MP Height Above or Below Ground (ft): 2.0 MP Elevation (ft): 6518.9

Remarks: Water level on 3/20/2013 at 25.3 feet below top of PVC. Installed hand slotted 4-inch PVC at 150 - 200 feet. Placed formation packer at 152 feet. Screen not sand packed and blank not grouted. Bentonite seal driven with 6-inch casing. Vertical datum is ACM Datum. Horizontal coordinates are WGS84 latitude and longitude.

WELL CONSTRUCTION



GRAPHICS

GEOLOGICAL DESCRIPTION

0.0 - 8.0' **Quartz Monzonite**
Weathered intrusive, drilling dry.

8.0 - 18.0' **Quartz Monzonite**
Fresh butte quartz monzonite, variable sizes of chips, some fracturing, traces of FeOx.

18.0 - 49.0' **Quartz Monzonite**
Hard drilling, even sized chips, no FeOx.

49.0 - 95.0' **Mafic Intrusive**
Hard drilling, consistent fine-grained sand size cuttings, light to dark gray, very little quartz, more mafic intrusive phase? Cuttings turn damp at 49 feet.
At 60 feet, stop advancing hole, wait 15 minutes, air lift estimated 1 - 2 gpm.
At 80 feet, stop advancing hole, wait 15 minutes, air lift, no apparent increase in flow.

95.0 - 100.0' **Mafic Intrusive**
Minor green gray clay, softer drilling.
At 100 feet, stop advancing hole, wait 15 minutes, air lift estimated 1 - 2 gpm, no apparent increase in flow.

100.0 - 200.0' **Mafic Intrusive**
Back into hard drilling, sand sized cuttings.
At 100 feet, stop advancing hole, wait 15 minutes, air lift, no apparent increase in flow.
At 120 feet, stop advancing hole, wait 15 minutes, air lift, no apparent increase in flow.
At 140 feet, stop advancing hole, wait 15 minutes, air lift, no apparent increase in flow.
At 160 feet, stop advancing hole, wait 15 minutes, air lift, no apparent increase in flow.
At 170 feet, stop advancing hole, wait 15 minutes, air lift, no apparent increase in flow.
At 180 feet, stop advancing hole, wait 15 minutes, air lift, no apparent increase in flow.
At 200 feet, no apparent increase in flow.

PVC WELL W/STEEL CASING K:\GINT\PROJECTS\12020 - MONITORING WELL LOGS.GPJ HYDHLN2.GDT 2/21/14

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW 12-16

Date Hole Started: 12/5/2012 Date Hole Finished: 12/7/2012

Client: Montana Resources
Project: Montana Resources
County: Silver Bow State: Montana
Property Owner: Montana Resources
Legal Description: SE SE SEC36 T4N R8W
Location Description: West Ridge - Moulton Road

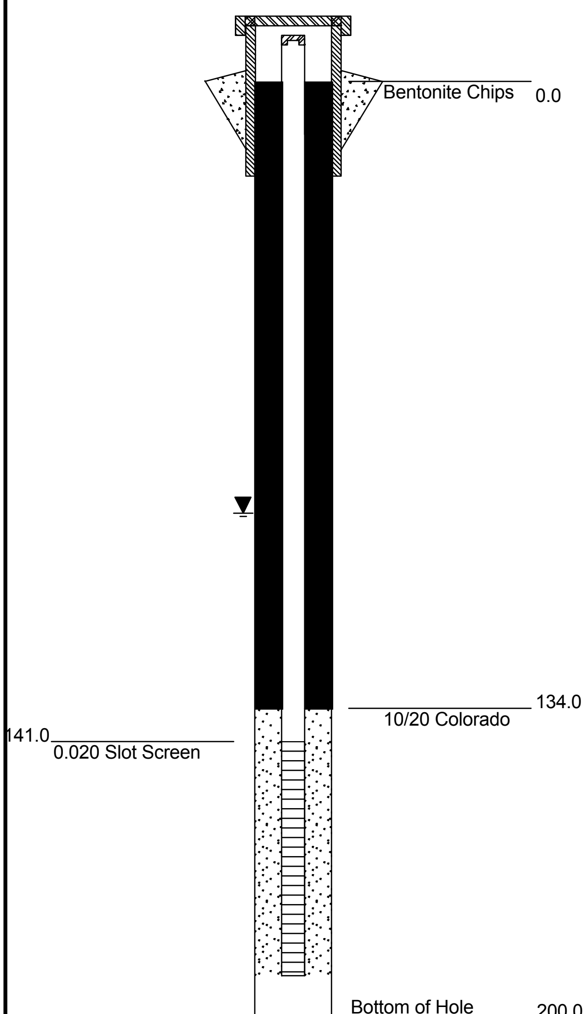
Recorded By: Larry Johnson
Drilling Company: O'Keefe
Driller: Dustin Timm
Drilling Method: Rotary
Drilling Fluids Used: Air, Water
Purpose of Hole: Groundwater Monitoring
Target Aquifer: Bedrock
Hole Diameter (in): 8"
Total Depth Drilled (ft): 200

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	4-inch, flush threaded, Sch 40, PVC	+2 - 191
Surface Casing Used?	Y	8" Steel	+2.5 - 17
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	141 - 191
Sand Pack?	Y	10/20 Silica Sand	134 - 191
Annular Seal?	Y	Kwik Plug - 3/8" Chips	-2.5 - 134
Surface Seal?	Y	Bentonite Chips	
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Air Lifting	
Water Samples Taken?	N		
Boring Samples Taken?	N		

Northing: 46.05086 Easting: 112.53053
Static Water Level Below MP: 94.28 Surface Casing Height (ft): 2.5
Date: 12/13/2012 Riser Height (ft): 2.0
MP Description: Top of PVC Ground Surface Elevation (ft): 6435.6
MP Height Above or Below Ground (ft): 2.0 MP Elevation (ft): 6487.58

Remarks: Drilled to 200 feet but hole caved to 191 feet after sitting overnight. Fracture zone at 152 - 159. First water about 65 feet. Vertical datum is ACM Datum. Horizontal coordinates are WGS84 latitude and longitude.

WELL CONSTRUCTION



SAMPLE NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
		0.0 - 25.0' **Quartz Monzonite** Light gray hornblend-biotite quartz monzonite. Drilling dry, very hard drilling.
		25.0 - 37.0' **Quartz Monzonite** Softer drilling. Dry.
		37.0 - 70.0' **Quartz Monzonite** Harder drilling. Damp returns at 65 to 70 feet. Air lifting <1 gpm at 70 feet.
		70.0 - 100.0' **Quartz Monzonite** Very little returns, damp cuttings may be sticking to wall of hole. Cuttings coming up as sand sized grains. Hard drilling.
		100.0 - 125.0' **Quartz Monzonite** Alternating short zones of hard and softer drilling. Harder at 110 to 120 feet. Making approximately 1 gpm at 125 feet.
		125.0 - 152.0' **Quartz Monzonite** Minor fracturing, variable chip size, weak limonite staining, no noticable increase in flow.
		152.0 - 159.0' **Quartz Monzonite** Strong limonite/hematite staining, some clay (limonite stained), making a little more water.
		159.0 - 200.0' **Quartz Monzonite** Fresh butte quartz monzonite, bit drops 3 to 6 inches at 170 feet, 172 feet, and 176 feet. Making 2 to 3 gpm at total depth.

Hydrometrics, Inc.

Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW 12-17

Date Hole Started: 12/10/2012 Date Hole Finished: 12/12/2012

Client: Montana Resources
Project: Montana Resources
County: Silver Bow State: Montana
Property Owner: Montana Resources
Legal Description: SE NE SEC36 T4N R8W
Location Description: West Ridge - Moulton Road

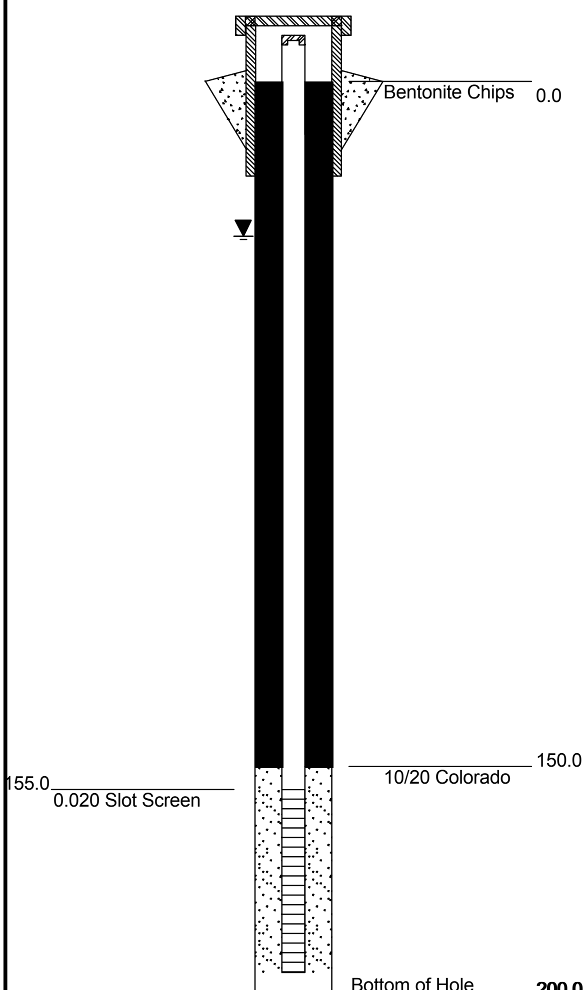
Recorded By: Larry Johnson
Drilling Company: O'Keefe
Driller: Dustin Timm
Drilling Method: Rotary
Drilling Fluids Used: Air, Water
Purpose of Hole: Groundwater Monitoring
Target Aquifer: Bedrock
Hole Diameter (in): 8"
Total Depth Drilled (ft): 200

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	4-inch, flush threaded, Sch 40, PVC	+2 - 195
Surface Casing Used?	Y	8" Steel	+2.5 - 17
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	155 - 195
Sand Pack?	Y	10/20 Silica Sand	150 - 195
Annular Seal?	Y	Kwik Plug - 3/8" Chips	-2.5 - 150
Surface Seal?	Y	Bentonite Chips	
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Air Lifting	
Water Samples Taken?	N		
Boring Samples Taken?	N		

Northing: 46.054979 Easting: 112.53276
Static Water Level Below MP: 35.89 Surface Casing Height (ft): 2.5
Date: 12/17/2012 Riser Height (ft): 2.0
MP Description: Top of PVC Ground Surface Elevation (ft): 6471
MP Height Above or Below Ground (ft): 2.0 MP Elevation (ft): 6472.97

Remarks: Drilled to 200 feet; hole caved to 195 feet after tripping out rods. Majority of water coming in at 85 to 90 feet. Vertical datum is ACM Datum. Horizontal coordinates are WGS84 latitude and longitude.

WELL CONSTRUCTION	SAMPLE NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION



0.0 - 18.0' Quartz Monzonite
Light gray hornblende-biotite quartz monzonite. Drilling dry: very soft drilling, moderate FeOx staining (FeOx also exposed in drill sump).

18.0 - 65.0' Quartz Monzonite
Hard drilling. Cuttings small (1/16 inch) chips. Dry. Driller reports bit drop 45 to 46 feet and 50 to 51 feet.

65.0 - 69.0' Quartz Monzonite
Softer drilling, strong FeOX at 68 to 69 feet.

69.0 - 80.0' Quartz Monzonite
Hard drilling.

80.0 - 100.0' Quartz Monzonite
Softer drilling; no FeOx. First water at 80 feet. Air lift 2 to 3 gpm at 90 feet. Left hole at 100 feet overnight; SWL = 37 feet next morning.

100.0 - 200.0' Quartz Monzonite
Generally hard drilling with softer zones (possible fractures) at 111 to 120 feet, 130 to 138 feet, 147 to 152 feet, 169 to 174 feet. No significant inflow noted below 90 feet.

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW 12-18

Date Hole Started: 12/12/2012 Date Hole Finished: 12/13/2012

Client: Montana Resources
Project: Montana Resources
County: Silver Bow State: Montana
Property Owner: Montana Resources
Legal Description: SE NE SEC36 T4N R82
Location Description: West Ridge - Moulton Road

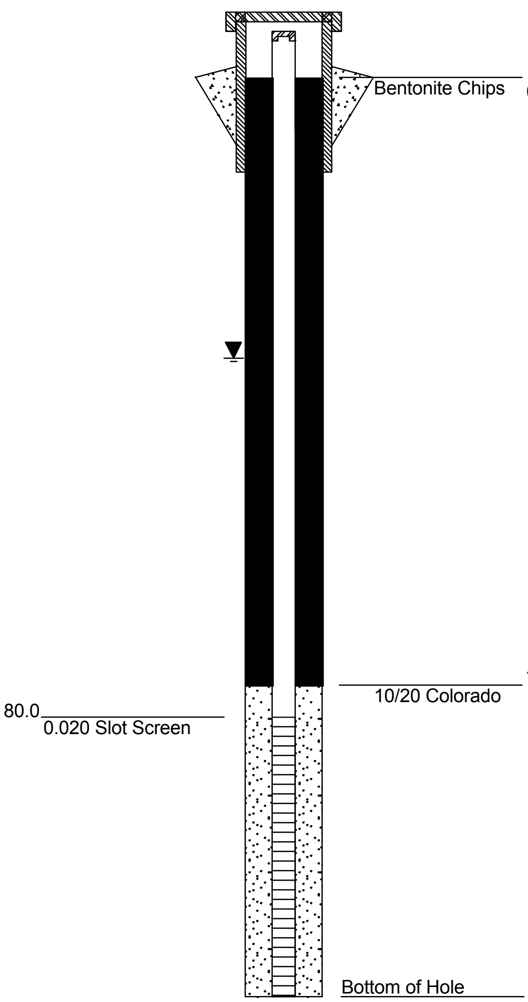
Recorded By: Larry Johnson
Drilling Company: O'Keefe
Driller: Dustin Timm
Drilling Method: Rotary
Drilling Fluids Used: Air, Water
Purpose of Hole: Groundwater Monitoring
Target Aquifer: Bedrock
Hole Diameter (in): 8"
Total Depth Drilled (ft): 115

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	4-inch, flush threaded, Sch 40, PVC	+2 - 115
Surface Casing Used?	Y	8" Steel	+2.5 - 17
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	80 - 115
Sand Pack?	Y	10/20Silica Sand	76-115
Annular Seal?	Y	Kwik Plug - 3/8" Chips	-2.5 - 76
Surface Seal?	Y	Bentonite Chips	
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Air Lifting	
Water Samples Taken?	N		
Boring Samples Taken?	N		

Northing: 46.054972 Easting: 112.532816
Static Water Level Below MP: 37.13 Surface Casing Height (ft): 2.5
Date: 12/17/2012 Riser Height (ft): 2.0
MP Description: Top of PVC Ground Surface Elevation (ft): 6470.5
MP Height Above or Below Ground (ft): 2.0 MP Elevation (ft): 6472.65

Remarks: Hole located approximately 25 feet west of MW 12-17. Majority of water coming in at 85 to 90 feet. Vertical datum is ACM Datum. Horizontal coordinates are WGS84 latitude and longitude.

WELL CONSTRUCTION



SAMPLE NOTES

GRAPHICS

GEOLOGICAL DESCRIPTION

0.0 - 18.0' **Quartz Monzonite**
Light gray hornblende-biotite quartz monzonite. Drilling dry: very soft drilling, moderate FeOx staining (FeOx also exposed in drill sump).

18.0 - 65.0' **Quartz Monzonite**
Hard drilling. Cuttings small (1/16 inch) chips. Dry. Driller reports bit drop 45 to 46 feet and 50 to 51 feet.

65.0 - 69.0' **Quartz Monzonite**
Softer drilling, strong FeOx at 68 to 69 feet.

69.0 - 80.0' **Quartz Monzonite**
Hard drilling.

80.0 - 100.0' **Quartz Monzonite**
Softer drilling; no FeOx. First water at 80 feet. Air lift 2 to 3 gpm at 90 feet. Left hole at 100 feet overnight; SWL = 37 feet next morning.

100.0 - 115.0' **Quartz Monzonite**
Hard drilling at 100 to 111 feet; softer at 111 to 115 feet. No significant inflow noted below 90 feet.

STANDARD_REV4 K:\GINTPROJECTS\12020 - MONITORING WELL LOGS.GPJ HYDHLN2.GDT 2/21/14

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW15-01

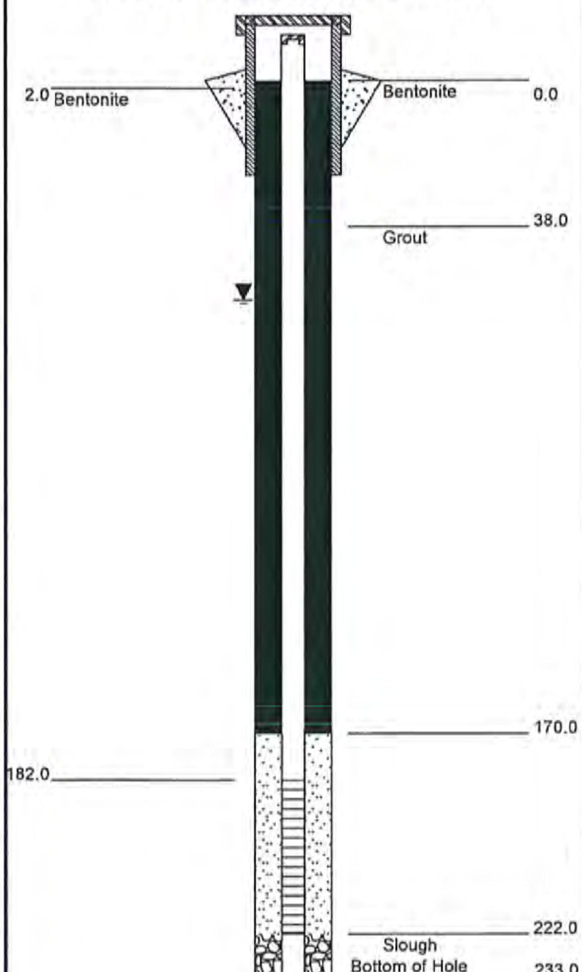
Date Hole Started: 4/14/2015 Date Hole Finished: 4/16/2015

Client: Montana Resources	WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Project: Montana Resources YDTI	Well Installed?	Y	4-inch, flush threaded, Sch 40, PVC	+2.60 - 222
County: Silver Bow State: Montana	Surface Casing Used?	Y	8" Steel, 10' Long	+3.00 - 7.00
Property Owner: Montana Resources	Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	182 - 221.5
Legal Description: T4N R8W SEC 36	Sand Pack?	Y	10/20 Silica Sand	170 - 229.5
Location Description: East of Moulton Road	Annular Seal?	Y	3/8" Bentonite Chips/Smooth Grout	2 - 38 / 38 - 170
	Surface Seal?	Y	Fine Bentonite Chips	0 - 2
Recorded By: Michael Peet	DEVELOPMENT/SAMPLING			
Drilling Company: O'Keefe	Well Developed?	Y	Surge/Pump	
Driller: Jerry Phillips	Water Samples Taken?	Y	Preliminary	
Drilling Method: Air Rotary	Boring Samples Taken?	Y	Drill Cuttings	0 - 233 feet, every 10 feet

Drilling Fluids Used: Air, Water	Northing: 145502.7	Easting: 129460.85
Purpose of Hole: Groundwater Monitoring	Static Water Level Below MP: 59.70	Surface Casing Height (ft): 3.00
Target Aquifer: Bedrock	Date: 4/27/2015	Riser Height (ft): 2.60
Hole Diameter (in): 8"	MP Description: Top of PVC	Ground Surface Elevation (ft): 6501.5
Total Depth Drilled (ft): 233	MP Height Above or Below Ground (ft): 2.60	MP Elevation (ft): 6504.13

Remarks: Water was encounted at approximately 120 feet. All flow measurements recorded from cyclone discharge with 5-gallon bucket and stopwatch. Horizontal coordinates in mine coordinate system. Elevations in ACM Datum.

WELL CONSTRUCTION



SAMPLE NOTES

GRAPHICS

GEOLOGICAL DESCRIPTION

0.0 - 3.0' Butte Quartz Monzonite
Weathered, soft.

3.0 - 60.0' Butte Quartz Monzonite
Grey, hard, sand size cuttings.

60.0 - 81.0' Butte Quartz Monzonite
Brown cuttings, slightly softer.

81.0 - 83.0' Butte Quartz Monzonite
Brown-orange cuttings, soft, sandy.

83.0 - 90.0' Butte Quartz Monzonite
Brown cuttings, soft, sandy.

90.0 - 93.0' Butte Quartz Monzonite
Orange-brown cuttings, sandy.

93.0 - 97.0' Butte Quartz Monzonite
Grey-brown cuttings, harder.

97.0 - 193.0' Butte Quartz Monzonite
Grey, competant, larger chips, less fines. Water likely coming in at approximately 133 feet (2 gpm at 133 feet and 163 feet). Driller says harder at 173 feet to 193 feet (4 gpm at 183 feet).

193.0 - 196.0' Butte Quartz Monzonite
Softer, grey cuttings.

196.0 - 197.0' Butte Quartz Monzonite
Broken, fractured zone, difficult drilling, tan-orange chips, likely Aplite.

197.0 - 203.0' Butte Quartz Monzonite
Competent, large >1-inch diameter chips likely coming from Butte Quartz Monzonite-Aplite contact.

203.0 - 219.0' Butte Quartz Monzonite
Hard, large chips coming out return from 196 feet fractured zone (7 gpm at 203 feet).

Continued Next Page

Hydrometrics, Inc.
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Helena, Montana

Monitor Well Log

Hole Name: MW15-01

Date Hole Started: 4/14/2015 Date Hole Finished: 4/16/2015

WELL CONSTRUCTION	SAMPLE NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
			219.0 - 220.0' **Butte Quartz Monzonite** Fractured zone, large chips, more water.
			220.0 - 223.0' **Butte Quartz Monzonite** Hard, traces of Aplite(?) (light colored weakly FeOx stained) (23 gpm at 223 feet).
			223.0 - 233.0' **Butte Quartz Monzonite** Soft drilling, grey cuttings, minor FeOx stained chips (23 gpm at 233 feet).

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW15-02

Date Hole Started: 4/9/2015 Date Hole Finished: 4/10/2015

Client: Montana Resources
Project: Montana Resources YDTI
County: Silver Bow State: Montana
Property Owner: Montana Resources
Legal Description: T4N R8W SEC 36
Location Description: East of Moulton Road

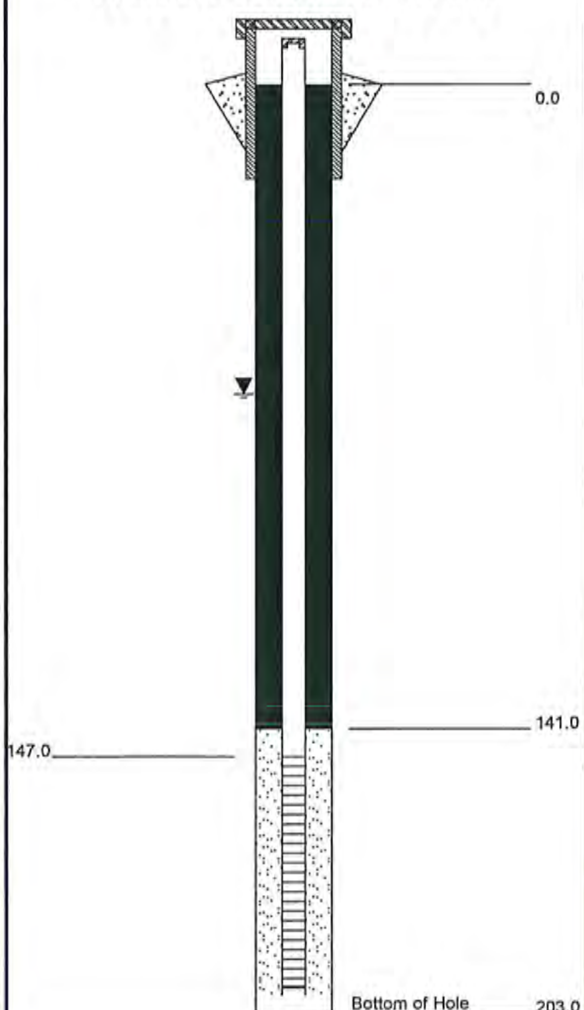
Recorded By: Michael Peet
Drilling Company: O'Keefe
Driller: Jerry Philips
Drilling Method: Air Rotary
Drilling Fluids Used: Air, Water
Purpose of Hole: Groundwater Monitoring
Target Aquifer: Bedrock
Hole Diameter (in): 8"
Total Depth Drilled (ft): 203

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	4-inch, flush threaded, Sch 40, PVC	+2.9 - 199
Surface Casing Used?	Y	10' of 8" Steel	+3.10 - 7.0
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	147 - 197
Sand Pack?	Y	10/20 Silica Sand	141 - 199
Annular Seal?	Y	3/8" Bentonite Chips	2.4 - 141
Surface Seal?	Y	Fine Bentonite	0 - 2.4
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Surge/Pump	
Water Samples Taken?	Y	Preliminary	
Boring Samples Taken?	Y	Drill Cuttings	0 - 203 feet, every 10 feet

Northing: 146315.05 Easting: 129436.01
Static Water Level Below MP: 70.68 Surface Casing Height (ft): 3.10
Date: 4/24/2015 Riser Height (ft): 2.90
MP Description: Top of PVC Ground Surface Elevation (ft): 6480.4
MP Height Above or Below Ground (ft): 2.90 MP Elevation (ft): 6483.34

Remarks: Water was encountered at approximately 90 feet. 2 gpm at 103 feet; 3 gpm at 123 feet; 3 gpm at 143 feet; 23 gpm at 163 feet, 23 gpm at 183 feet; 23 gpm at 203 feet. All flows recorded volumetrically by airlifting. Horizontal coordinates in mine coordinate system. Elevations in ACM Datum.

WELL CONSTRUCTION



SAMPLE NOTES | GRAPHICS

GEOLOGICAL DESCRIPTION

0.0 - 18.0' Butte Quartz Monzonite
FeOx stained, decomposed, gray turning to orange-brown from 0 to 10 feet, moderately soft, sand sized chips.

18.0 - 20.0' Butte Quartz Monzonite
Increasing hardness, orange-brown.

20.0 - 38.0' Butte Quartz Monzonite
Gray-brown, less FeOx (only trace), competent rock, all gray at appoximately 22 feet.

38.0 - 40.0' Butte Quartz Monzonite
Orange brown, FeOx stained, soft.

40.0 - 85.0' Butte Quartz Monzonite
Gray, semi-soft. Larger chips, trace FeOx

85.0 - 95.0' Butte Quartz Monzonite
Gray-brown, fine cuttings, damp. Abundant fine sandy cuttings. First water at approximately 90 feet.

95.0 - 143.0' Butte Quartz Monzonite
Gray-brown, coarser (up to 3/4-inch) cuttings. Harder drilling, 2%, orange, rusty FeOx staining.

143.0 - 175.0' Butte Quartz Monzonite
Same as above with more FeOx on fractured surfaces, larger chips. Yield increases from 3 gpm at 143 feet to 23 gpm at 163 feet.

175.0 - 193.0' Butte Quartz Monzonite
Competent semi-hard, minor FeOx - approximately 1%.

193.0 - 203.0' Butte Quartz Monzonite
Slightly softer, 80% chips fresh, 20% dark green stained plus FeOx. Driller says softer drilling, possibly fractured, 23 gpm at 203 feet.

Hydrometrics, Inc.

Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW15-03

Date Hole Started: 4/6/2015 Date Hole Finished: 4/9/2015

Client: Montana Resources	
Project: Montana Resources YDTI	
County: Silver Bow	State: Montana
Property Owner: Montana Resources	
Legal Description: T4N R8W SEC 36	
Location Description: East of Moulton Road; 30 feet from Well 12-16	
Recorded By: Bob Anderson/Michael Peet	
Drilling Company: O'Keefe	
Driller: Jerry Philips	
Drilling Method: Air Rotary	
Drilling Fluids Used: Air, Water	
Purpose of Hole: Groundwater Monitoring	
Target Aquifer: Deep Bedrock	
Hole Diameter (in): 8"	
Total Depth Drilled (ft): 403	

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	4-inch, flush threaded, Sch 40, PVC	+2.62 - 386
Surface Casing Used?	Y	8" Steel, 19' Long	+2.80 - 16.2
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	345.5 - 385.5
Sand Pack?	Y	10/20 Silica Sand	335 - 389
Annular Seal?	Y	3/8" Betonite Chips	3 - 335
Surface Seal?	Y	Fine Bentonite	0 - 3
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Surge/Pump	
Water Samples Taken?	Y	Preliminary	
Boring Samples Taken?	Y	Cuttings	0 - 403 feet, every 10 feet

Northing: 146002.63 Easting: 129411.93

Static Water Level Below MP: 109.52 Surface Casing Height (ft): 2.80

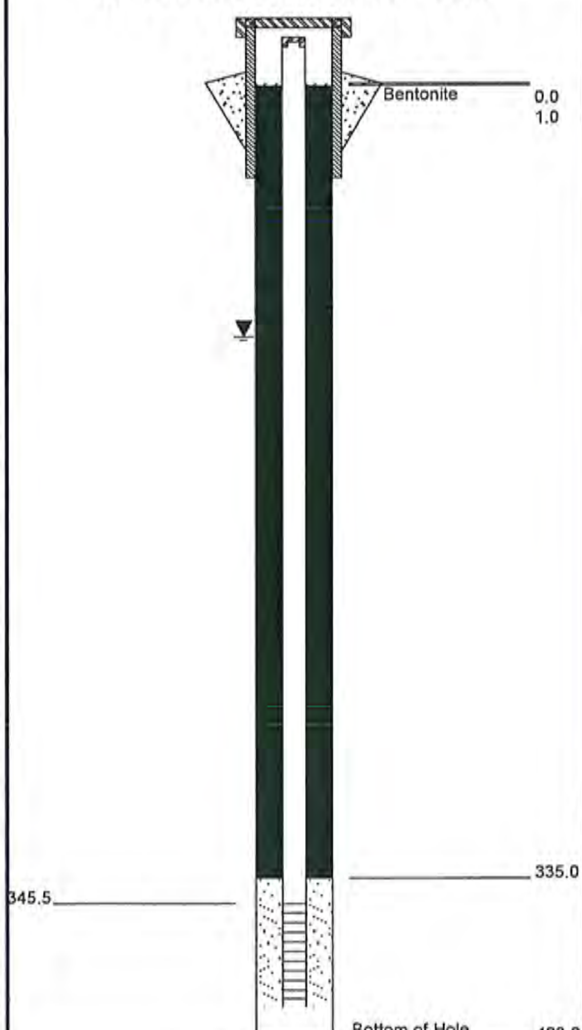
Date: 4/24/2015 Riser Height (ft): 2.62

MP Description: Top of PVC Ground Surface Elevation (ft): 6484.8

MP Height Above or Below Ground (ft): 2.62 MP Elevation (ft): 6487.41

Remarks: Water was encountered at approximately 80 feet. <1 gpm at 83 feet (may be drill water; 1-2 gpm at 143 feet; 4 gpm at 203 feet; 4 gpm at 243 feet; 6 gpm at 303 feet; 2-3 gpm at 363 feet (questionable measurement). All flows recorded volumetrically by air lifting. Sloughed to 389 feet before well constructed; placed 3 feet of sand on top of slough. Horizontal coordinates in mine coordinate system. Elevations in ACM Datum.

WELL CONSTRUCTION



SAMPLE NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
		0.0 - 3.0' Butte Quartz Monzonite Soft, regolith.
		3.0 - 21.0' Butte Quartz Monzonite Moderately hard, light gray, supergene alteration. Trace FeOx, partially altered biotite. Damp.
		21.0 - 25.0' Butte Quartz Monzonite Softer, injecting water.
		25.0 - 60.0' Butte Quartz Monzonite Harder drilling, fine cuttings, dark gray.
		63.0 - 90.0' Butte Quartz Monzonite Slightly more clay, larger chips. <1 gpm at 83 feet (may be drill water).
		90.0 - 101.0' Butte Quartz Monzonite Fines and rock fragments up to small gravel, trace orange FeOx.
		101.0 - 102.0' Butte Quartz Monzonite Orange-brown FeOx with traces of gouge (thin veinlet).
		102.0 - 108.0' Butte Quartz Monzonite Gray.
		108.0 - 130.0' Butte Quartz Monzonite Light gray-green, trace orange FeOx, moderately hard. Moist.
		130.0 - 145.0' Butte Quartz Monzonite Harder, larger chips/light gray-green. 1 to 2 gpm.
		145.0 - 163.0' Butte Quartz Monzonite Hard, fresh, minor FeOx staining, up to 1/2 inch chips. Softer 159 to 163.
		163.0 - 169.0' Butte Quartz Monzonite Harder drilling.
		169.0 - 187.0' Butte Quartz Monzonite More fines and clay components to chips, gray-green, alternate soft/hard zones. Softer 185 to 187.
		187.0 - 220.0' Butte Quartz Monzonite Harder, larger chips (more fractures?), flat chips, gray-green, less FeOx stained chips. 4 gpm at 203 feet.
		220.0 - 258.0' Butte Quartz Monzonite Same as above with more FeOx on fx surface (still only minor FeOx). Driller says softer, more fractures 236 to 238 feet. More FeOx staining at 243 to 250 feet.
		258.0 - 263.0' Butte Quartz Monzonite Softer rock, chips still competent rock. Minor FeOx stained chips.
		263.0 - 270.0' Butte Quartz Monzonite Harder, gray.
		270.0 - 315.0' Butte Quartz Monzonite Slightly softer, gray, more fines with chips.
		315.0 - 401.0' Butte Quartz Monzonite Fresh, competent, trace FeOx. 360-370 feet: More chlor/gn argillic alternation (minor green chips).

Continued Next Page

WELL CONSTRUCTION	SAMPLE NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
			401.0 - 403.0' **Butte Quartz Monzonite** Softer, traces of clay, medium gray.

Hydrometrics, Inc.

Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW15-04

Date Hole Started: 4/10/2015 Date Hole Finished: 4/14/2015

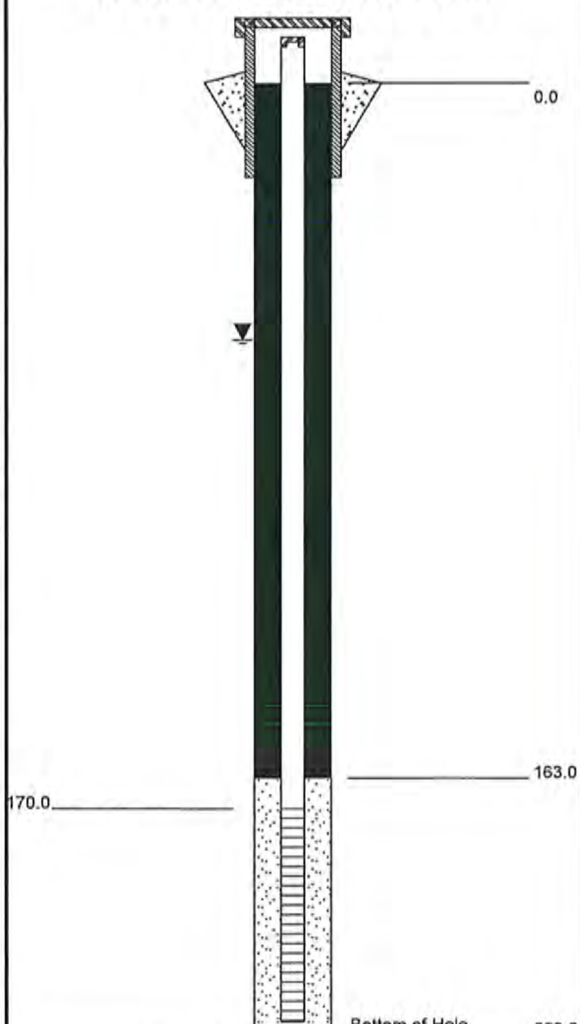
Client: Montana Resources	
Project: Montana Resources YDTI	
County: Silver Bow	State: Montana
Property Owner: Montana Resources	
Legal Description: T4N R8W SEC 36	
Location Description: East of Moulton Road and Well 12-16	
Recorded By: Michael Peet	
Drilling Company: O'Keefe	
Driller: Jerry Phillips	
Drilling Method: Air Rotary	
Drilling Fluids Used: Air, Water	
Purpose of Hole: Groundwater Monitoring	
Target Aquifer: Deep Bedrock	
Hole Diameter (in): 8"	
Total Depth Drilled (ft): 223	

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	4-inch, flush threaded, Sch 40, PVC	+2.55 - 220
Surface Casing Used?	Y	8" Steel, 10' Long	+2.70 - 7.30
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	170 - 220
Sand Pack?	Y	10/20 Silica Sand	163 - 220
Annular Seal?	Y	3/8" Bentonite Chips	0 - 163
Surface Seal?	Y	Bentonite	0 - 3
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Surge/Pump	
Water Samples Taken?	Y	Preliminary	
Boring Samples Taken?	Y	Drill Cuttings	0 - 223 feet, every 10 feet.

Northing: 145875.35	Easting: 129974.9
Static Water Level Below MP: 62.74	Surface Casing Height (ft): 2.70
Date: 4/24/2015	Riser Height (ft): 2.55
MP Description: Top of PVC	Ground Surface Elevation (ft): 6433.4
MP Height Above or Below Ground (ft): 2.55	MP Elevation (ft): 6435.98

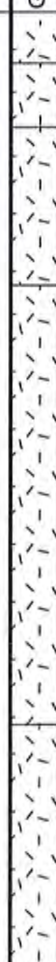
Remarks: Very little groundwater encountered. Hole sloughed from 220 to 223 feet. Horizontal coordinates in mine coordinate system. Elevations in ACM Datum.

WELL CONSTRUCTION



SAMPLE NOTES

GRAPHICS



GEOLOGICAL DESCRIPTION

0.0 - 10.0' **Weathered Butte Quartz Monzonite**
Transitions to hard, gray Butte Quartz Monzonite. Dry, dusty.

10.0 - 25.0' **Butte Quartz Monzonite**
Hard, gray, fresh, mostly sandy cuttings. Injecting water.

25.0 - 62.0' **Butte Quartz Monzonite**
Brown-gray with slight red-orange color, softer drilling, weathered, weak FeOx staining.

62.0 - 165.0' **Butte Quartz Monzonite**
Similar to above with slightly more FeOx (FeOx still only minor staining), softer.

Stopped drilling at 105 feet to check for water (more moisture in cuttings). No water, only damp cuttings.

113 - 142 feet: Orange-brown cuttings, more FeOx.

165.0 - 223.0' **Butte Quartz Monzonite**
Slightly harder, grey-brown, mostly sand size cuttings. Increased moisture at 165 to 183 feet.

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW15-05

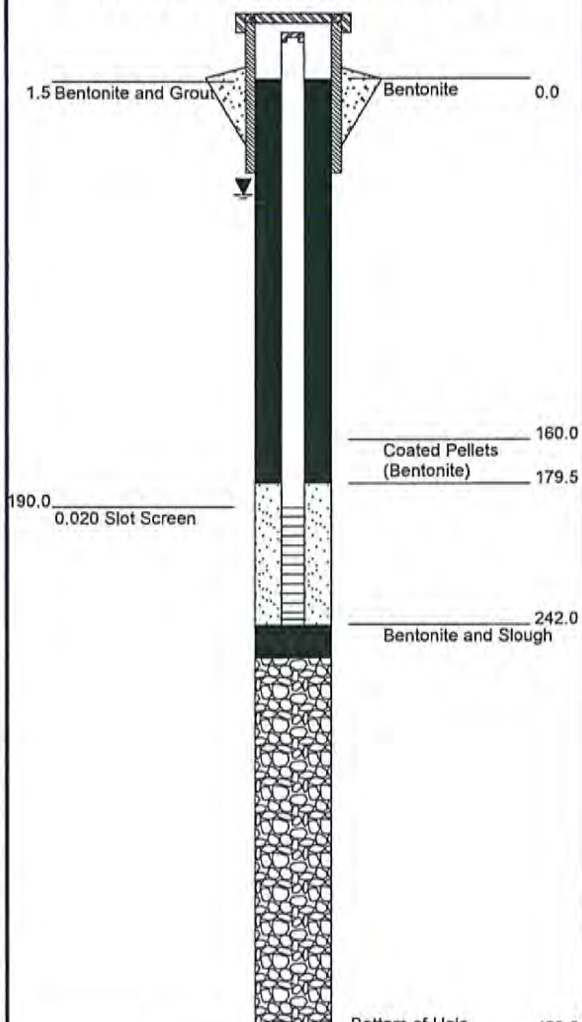
Date Hole Started: 4/20/2015 Date Hole Finished: 4/27/2015

Client: Montana Resources	**WELL COMPLETION**	**Y/N**	**DESCRIPTION**	**INTERVAL**
Project: Montana Resources YDTI	Well Installed?	Y	4-inch, flush threaded, Sch 40, PVC	+2.66 - 240
County: Silver Bow State: Montana	Surface Casing Used?	Y	8" Steel, 20' Long	+3.00 to 17.00
Property Owner: Montana Resources	Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	190 - 240
Legal Description: T4N R8W SEC 36	Sand Pack?	Y	10/20 Silica Sand	179.5 - 242
Location Description: East of Moulton Road	Annular Seal?	Y	Bentonite Pellets, 3/8" Chips, Smooth Grout	
	Surface Seal?	Y	Fine Bentonite	0 - 3
Recorded By: Michael Peet	**DEVELOPMENT/SAMPLING**			
Drilling Company: O'Keefe	Well Developed?	Y	Surge/Pump	
Driller: Jerry Phillips	Water Samples Taken?	Y	Preliminary	
Drilling Method: Air Rotary	Boring Samples Taken?	Y	Drill Cuttings	Every 10 feet

Drilling Fluids Used: Air, Water	Northing: 147317.32	Easting: 128911.87
Purpose of Hole: Groundwater Monitoring	Static Water Level Below MP: 54.25	Surface Casing Height (ft): 3.00
Target Aquifer: Bedrock	Date: 4/30/2015	Riser Height (ft): 2.66
Hole Diameter (in): 8"	MP Description: Top of PVC	Ground Surface Elevation (ft): 6466.1
Total Depth Drilled (ft): 423	MP Height Above or Below Ground (ft): 2.66	MP Elevation (ft): 6468.72

Remarks: Water was encounted at approximately 100 feet. Drilled to 423 feet. Severe sloughing/caving in hole below 300 feet. Backfilled bottom of hole and completed shallower well.
Annular Seal: 0 - 20 feet = 3/8-inch chips bentonite; 20 - 153 feet = smooth grout; 153 - 160 = 3/8-inch chips bentonite; 160 - 179.5 = coated bentonite pellets. All flows recorded from cyclone discharge with bucket and stopwatch.
Horizontal coordinates in mine coordinate system. Elevations in ACM Datum.

WELL CONSTRUCTION



SAMPLE NOTES

GRAPHICS

GEOLOGICAL DESCRIPTION

0.0 - 20.0' **Butte Quartz Monzonite**
Grey, medium hard, fine cuttings. Dry, dusty.

20.0 - 66.0' **Butte Quartz Monzonite**
Harder drilling. Larger chips, large amount of water required to keep hole open, 10% weak orange FeOx stained chips.

66.0 - 88.0' **Butte Quartz Monzonite**
Softer, grey-brown, abundant fines.

88.0 - 97.0' **Butte Quartz Monzonite**
Harder, grey cuttings, 2% weak FeOx chips.

97.0 - 118.0' **Butte Quartz Monzonite**
Similar hardness, grey-brown-green cuttings, 4% weak orange FeOx chips (approximately 0.5 gpm at 103 feet).

118.0 - 122.0' **Butte Quartz Monzonite**
Grey, medium hard, less FeOx (1 - 2% weak stained, more mafics and green stained chips) at 118 to 122 feet (0.5 gpm at 122 feet).

122.0 - 148.0' **Butte Quartz Monzonite**
Grey-brown, 5% FeOx stained chips, less mafics (usual Butte Quartz Monzonite comp.) (1 gpm at 143 feet).

148.0 - 165.0' **Butte Quartz Monzonite**
Same as above, but softer (1 gpm at 163 feet).

165.0 - 200.0' **Butte Quartz Monzonite**
Similar, but hard (q-vein fragments at approximately 188 feet) (3 gpm at 183 feet).

200.0 - 226.0' **Butte Quartz Monzonite**
Grey-brown-green cuttings, moderate hardness, weak chlorite-green color, approximately 3% FeOx. Qtz-vein fragments at 208 feet. Approximately 5% FeOx stained chips at 219 feet (5 gpm at 203 feet).

226.0 - 423.0' **Butte Quartz Monzonite**
Grey-brown, 5% FeOx chips, medium to hard, traces of Aplite at approximately 227 feet. Calcite vein fragments at 308 feet. FeOx stained q-vein fragments at 341 feet, approximately 2% of chips. More chlorite green coloration at 330 to 423 feet. 6-inch fractured zone, drill sticks, trace of gouge in cuttings at 380 feet. (15 gpm at 243 feet. 18 gpm at 263 feet. 18 gpm at 303 feet. 23 gpm at 343 feet. 18 gpm at 403 feet.)

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW15-06

Date Hole Started: 4/27/2015 Date Hole Finished: 6/18/2015

Client: Montana Resources
Project: Montana Resources YDTI
County: Silver Bow State: Montana
Property Owner: Montana Resources
Legal Description: T4N R8W SE NE SEC 36
Location Description: East of Moulton Road

Recorded By: Michael Peet
Drilling Company: O'Keefe
Driller: Jerry Phillips/L. Gagnon
Drilling Method: Air Rotary/Hammer
Drilling Fluids Used: Air, Water
Purpose of Hole: Groundwater Monitoring
Target Aquifer: Deep Bedrock
Hole Diameter (in): 8"
Total Depth Drilled (ft): 423

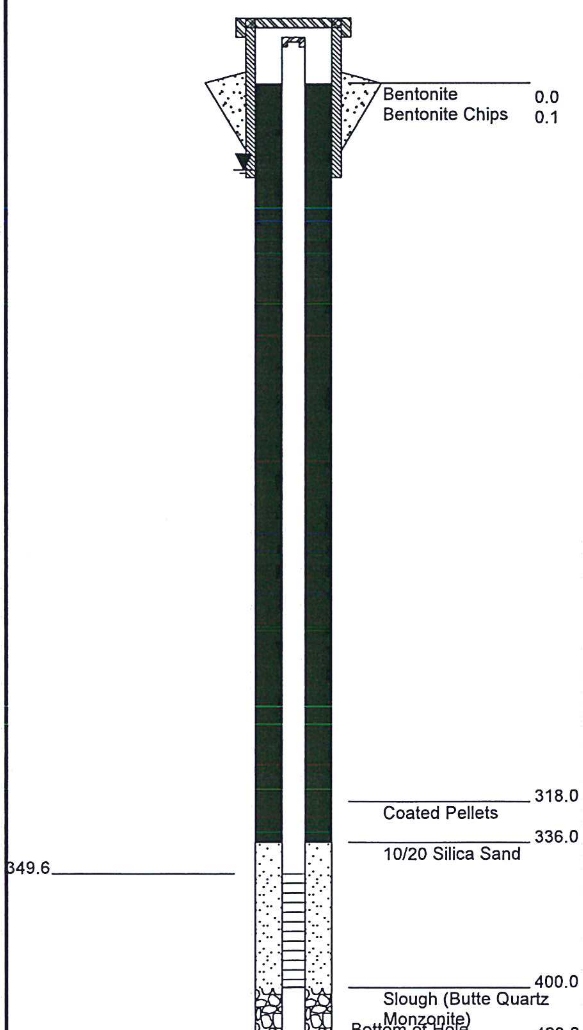
WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	+2.05 - 400
Surface Casing Used?	Y	8" Steel	7.4 - +2.6
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	350 - 400
Sand Pack?	Y	10/20 Silica Sand	336 - 400
Annular Seal?	Y	3/8" Bentonite Chips/Coated Pellets	0 - 336
Surface Seal?	Y	Bentonite Chips (fine)	0 - 4

DEVELOPMENT/SAMPLING	
Well Developed?	N
Water Samples Taken?	N
Boring Samples Taken?	N

Northing: 147284.007 Easting: 128909.305
Static Water Level Below MP: 40.42 Surface Casing Height (ft): +2.60
Date: 8/18/2015 Riser Height (ft): +2.0
MP Description: 2" PVC Ground Surface Elevation (ft): 6466.9
MP Height Above or Below Ground (ft): +2.0 MP Elevation (ft): 6468.97

Remarks: Water was encountered from 100 to 110 feet. Samples not taken due to close proximity to hole MW15-05. Approximately 3 feet of fines filling bottom of screen at approximately 397 to 400 feet. This well was drilled approximately 25 feet SSW of MW15-05. Horizontal coordinates in mine coordinate system. Elevations in ACM Datum.

WELL CONSTRUCTION



SAMPLE NOTES

GRAPHICS

GEOLOGICAL DESCRIPTION

0.0 - 20.0' **Butte Quartz Monzonite**
Grey, medium hard, fine cuttings. Dry, dusty.

20.0 - 66.0' **Butte Quartz Monzonite**
Harder drilling. 10% weak orange FeOx stained chips.

66.0 - 88.0' **Butte Quartz Monzonite**
Softer, grey-brown, abundant fines.

88.0 - 97.0' **Butte Quartz Monzonite**
Harder, grey cuttings, 2% weak FeOx chips.

97.0 - 118.0' **Butte Quartz Monzonite**
Similar hardness, grey-brown-green cuttings, 4% weak orange FeOx chips.

118.0 - 122.0' **Butte Quartz Monzonite**
Grey, medium hard, less FeOx.

122.0 - 148.0' **Butte Quartz Monzonite**
Grey-brown, 5% FeOx stained chips, less mafics (usual Butte Quartz Monzonite comp.).

148.0 - 165.0' **Butte Quartz Monzonite**
Same as above, but softer.

165.0 - 200.0' **Butte Quartz Monzonite**
Similar to above but hard.

200.0 - 226.0' **Butte Quartz Monzonite**
Grey-brown-green cuttings, moderate hardness, weak chlorite-green color, approximately 3% FeOx stained chips.

226.0 - 423.0' **Butte Quartz Monzonite**
Grey-brown, 5% FeOx chips, medium to hard drilling.

At approximately 238 feet, fractured zone, large chips from return, drill torques slightly, more water.

315.0 - 318.0' Driller says drills like fractured zone, more water.

330.0 - 423.0' More chlorite-green coloration (9 gpm at 423 feet).

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW15-07

Date Hole Started: 7/24/2015 Date Hole Finished: 7/28/2015

Client: Montana Resources
Project: Montana Resources YDTI
County: Silver Bow State: Montana
Property Owner: Montana Resources
Legal Description: T4N R8W SE1/4 SEC 36
Location Description: West of Moulton Road

Recorded By: Michael Peet
Drilling Company: O'Keefe
Driller: Jerry Phillips
Drilling Method: Reverse Circulation
Drilling Fluids Used: Air, Water
Purpose of Hole: Groundwater Monitoring
Target Aquifer: Bedrock
Hole Diameter (in): 8"
Total Depth Drilled (ft): 203

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	4-inch, flush threaded, Sch 40, PVC	+2.45 - 203
Surface Casing Used?	Y	8" Steel	+2.80 to 16
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	162.5 - 202.5
Sand Pack?	Y	10/20 Silica Sand	150 - 203
Annular Seal?	Y	3/8" Bentonite Chips	1.20 - 150
Surface Seal?	N		
DEVELOPMENT/SAMPLING			
Well Developed?	N		
Water Samples Taken?	N		
Boring Samples Taken?	Y	Cuttings	Every 10 feet

Northing: 146037.876 Easting: 129013.678
Static Water Level Below MP: 73.58 Surface Casing Height (ft): +2.80
Date: 7/30/2015 Riser Height (ft): +2.45
MP Description: 4" PVC Ground Surface Elevation (ft): 6462
MP Height Above or Below Ground (ft): +2.45 MP Elevation (ft): 6464.65

Remarks: Water was encountered at approximately 103 feet. All well yield estimates determined through air lifting. Horizontal coordinates in mine coordinate system. Elevations in ACM Datum.

WELL CONSTRUCTION

SAMPLE NOTES | GRAPHICS

GEOLOGICAL DESCRIPTION

0.0 - 3.0' Butte Quartz Monzonite
Moderately soft fill and decomposed Butte Quartz Monzonite, gray-tan, dry, dusty.

3.0 - 30.0' Butte Quartz Monzonite
Hard, medium gray, traces of clayey chips. Traces of bright-white soft argillically altered chips, dry, dusty.

30.0 - 33.0' Butte Quartz Monzonite
Gray-brown due to iron staining on chips, dry, dusty.

33.0 - 41.0' Butte Quartz Monzonite
Hard, gray, Butte Quartz Monzonite, dry, dusty, less iron.

41.0 - 41.5' Butte Quartz Monzonite
Brown-gray cuttings due to greater iron staining (still only minor percentage of chips stained).

41.5 - 50.0' Butte Quartz Monzonite
Hard, medium gray, 5 percent orange (iron) chips. At 43 feet, no water in hole after weekend.

50.0 - 53.0' Butte Quartz Monzonite
Similar to above, but softer.

53.0 - 57.0' Butte Quartz Monzonite
Hard, gray, 5 percent iron stained chips.

57.0 - 60.0' Butte Quartz Monzonite
Similar to above, but softer drilling.

60.0 - 70.0' Butte Quartz Monzonite
Similar to above, but harder drilling. Beginning at 63 feet, no detectable water from hole.

70.0 - 90.0' Butte Quartz Monzonite
Softer, medium gray, minor iron. No detectable water from hole.

90.0 - 108.0' Butte Quartz Monzonite
Medium hard, 5 percent iron stained chips. Approximately 1 gpm at 103 feet.

108.0 - 134.0' Butte Quartz Monzonite
Soft, gray-tan cuttings, small (fine chips), less iron. Approximately 1 gpm at 123 feet.

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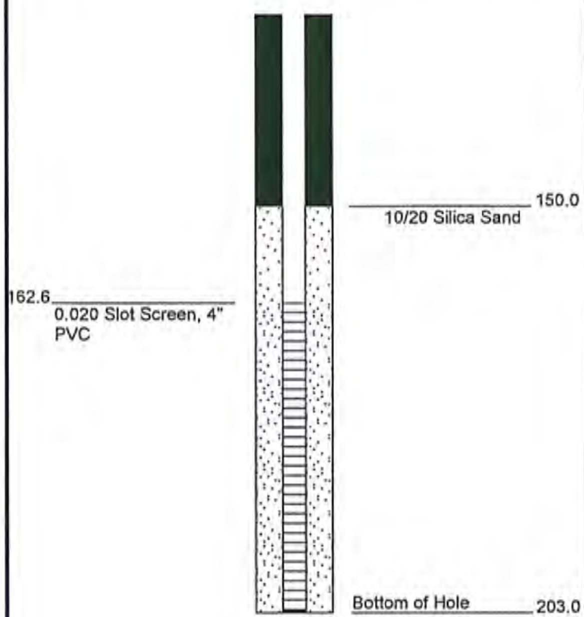
WELL CONSTRUCTION



SAMPLE NOTES

GRAPHICS

GEOLOGICAL DESCRIPTION

134.0 - 140.0' **Butte Quartz Monzonite**
Similar to above, but harder drilling.

140.0 - 141.0' **Butte Quartz Monzonite**
Very soft, large chips, brown (likely fractured zone).

141.0 - 153.0' **Butte Quartz Monzonite**
Hard, gray, mostly fine cuttings, trace of 1 to 2 mm orange limonite veinlets, traces of epidote in larger chips. Approximately 1 gpm at 143 feet.

153.0 - 165.0' **Butte Quartz Monzonite**
Larger cuttings, up to fine gravel-size. Approximately 1 gpm at 163 feet.

165.0 - 168.0' **Butte Quartz Monzonite**
Fault or vein, brown to orange to blue-white, clay (gouge?) chunks with brown, soft limonitic chunks, tan milky cuttings from cyclone.

168.0 - 180.0' **Butte Quartz Monzonite**
Hard, gray to bluish green chips, traces of fresh pyrite, mostly reduced, only traces of iron, large cuttings.

180.0 - 182.0' **Butte Quartz Monzonite**
Orange-brown cuttings, mostly oxidized, likely a thin limonite veinlet.

182.0 - 196.0' **Butte Quartz Monzonite**
Hard, mostly reduced Butte Quartz Monzonite, traces of pyrite. Approximately 1 gpm at 183 feet.

196.0 - 199.0' **Butte Quartz Monzonite**
Brown-green cuttings, soft, abundant fines in cuttings, mostly oxidized, orange-brown limonitic chips.

199.0 - 203.0' **Butte Quartz Monzonite**
Hard, gray, Butte Quartz Monzonite, fine to medium sized chips. Approximately 1 gpm at 203 feet.

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW15-08

Date Hole Started: 7/28/2015 Date Hole Finished: 7/29/2015

Client: Montana Resources
Project: Montana Resources YDTI
County: Silver Bow State: Montana
Property Owner: Montana Resources
Legal Description: T4N R8W SE1/4 SEC 36
Location Description: West of Moulton Road

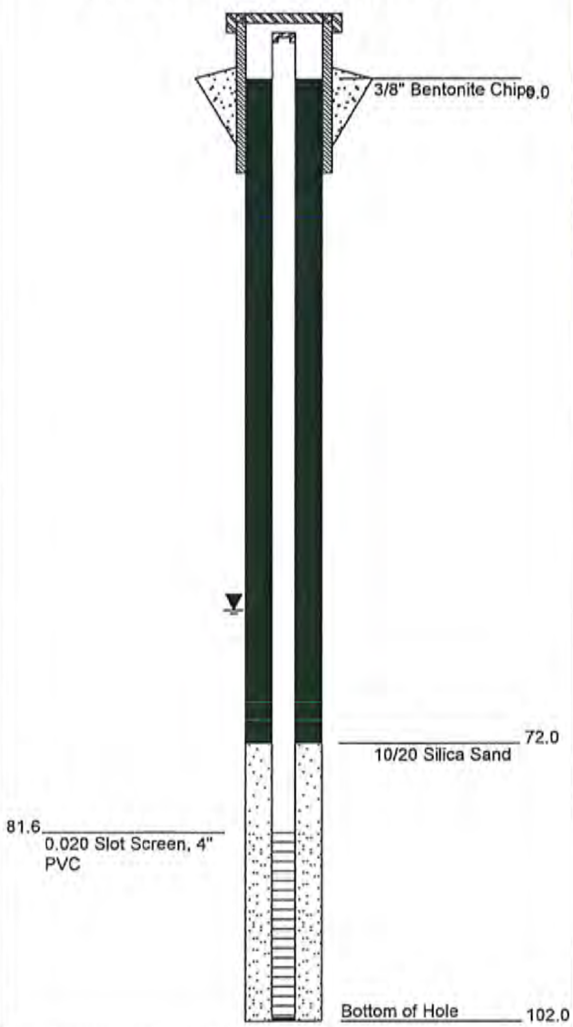
Recorded By: Michael Peet
Drilling Company: O'Keefe
Driller: Jerry Phillips
Drilling Method: Reverse Circulation Percussion
Drilling Fluids Used: Air, Water
Purpose of Hole: Groundwater Monitoring
Target Aquifer: Perched bedrock groundwater
Hole Diameter (in): 8"
Total Depth Drilled (ft): 102

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	4-inch, flush threaded, Sch 40, PVC	+2.15 to 102
Surface Casing Used?	Y	8" Steel	+2.45 - 19
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	81.5 - 101.5
Sand Pack?	Y	10/20 Silica Sand	72 - 102
Annular Seal?	Y	3/8" Bentonite Chips	0 - 72
Surface Seal?	N		
DEVELOPMENT/SAMPLING			
Well Developed?	N		
Water Samples Taken?	N		
Boring Samples Taken?	N		

Northing: 146045.581 Easting: 129020.815
Static Water Level Below MP: 59.75 Surface Casing Height (ft): +2.45
Date: 7/31/2015 Riser Height (ft): +2.15
MP Description: 4" PVC Casing Ground Surface Elevation (ft): 6462.5
MP Height Above or Below Ground (ft): +2.15 MP Elevation (ft): 6464.57

Remarks: Water was encountered at approximately 82 feet. Horizontal coordinates in mine coordinate system. Elevations in ACM Datum.

WELL CONSTRUCTION



SAMPLE NOTES | GRAPHICS

GEOLOGICAL DESCRIPTION

0.0 - 25.0' **Butte Quartz Monzonite**
Hard, gray, Butte Quartz Monzonite, small cuttings, dry, dusty.

25.0 - 47.0' **Butte Quartz Monzonite**
Fairly soft drilling. At 38 feet, slightly damp, clumps in hand. Beginning at 40 feet, dry and dusty again.

47.0 - 62.0' **Butte Quartz Monzonite**
Hard drilling, dry, dusty.

62.0 - 70.0' **Butte Quartz Monzonite**
Hard drilling, dry, dusty. At 70 feet, begin water injection to control dust, water is shut off and cleared from hole prior to water checks.

70.0 - 91.0' **Butte Quartz Monzonite**
Softer, medium-gray, minor iron staining. At 82 feet, shut off air and wait 10 minutes; trace water from air lifting.

91.0 - 102.0' **Butte Quartz Monzonite**
More iron staining, brown-gray cuttings. At 92 feet, shut off air for water check, 3 feet in hole after 23 minutes. At 102 feet, water check with air off, 3 feet in hole after 21 minutes; making less than 1 gpm.

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

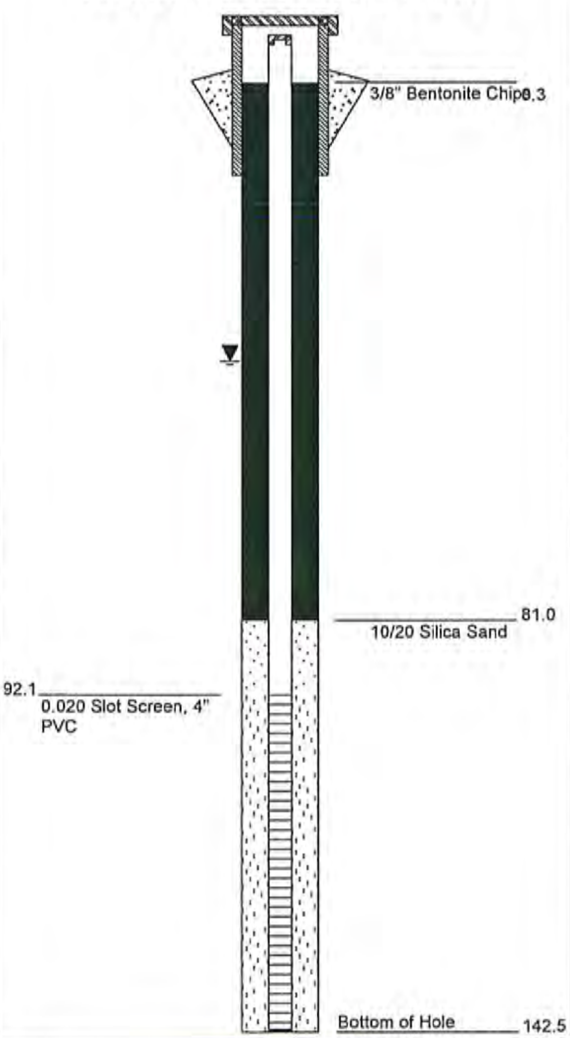
Hole Name: MW15-09

Date Hole Started: 7/29/2015 Date Hole Finished: 7/30/2015

Client: Montana Resources	**WELL COMPLETION**	**Y/N**	**DESCRIPTION**		**INTERVAL**
Project: Montana Resources YDTI	Well Installed?	Y	4-inch, flush threaded, Sch 40, PVC		+2.10 - 142.5
County: Silver Bow State: Montana	Surface Casing Used?	Y	8" Steel		+2.65 - 17.5
Property Owner: Montana Resources	Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC		92 - 142
Legal Description: T4N R7W NW1/4 SEC 31	Sand Pack?	Y	10/20 Silica Sand		81 - 142.5
Location Description: NW of YDTI	Annular Seal?	Y	3/8" Bentonite Chips		+0.25 - 81
	Surface Seal?	N			
Recorded By: Michael Peet	**DEVELOPMENT/SAMPLING**				
Drilling Company: O'Keefe	Well Developed?	N			
Driller: Jerry Phillips	Water Samples Taken?	N			
Drilling Method: Reverse Circulation Percussion	Boring Samples Taken?	Y	Cuttings		Every 10 feet
Drilling Fluids Used: Air, Water	Northing: 149096.971		Easting: 132336.814		
Purpose of Hole: Groundwater Monitoring	Static Water Level Below MP: 44.15			Surface Casing Height (ft): +2.65	
Target Aquifer: Bedrock	Date: 7/31/2015			Riser Height (ft): +2.10	
Hole Diameter (in): 8"	MP Description: 4" PVC			Ground Surface Elevation (ft): 6453	
Total Depth Drilled (ft): 142.5	MP Height Above or Below Ground (ft): +2.10			MP Elevation (ft): 6455.25	

Remarks: Water was encountered at approximately 82 feet. Horizontal coordinates in mine coordinate system. Elevations in ACM Datum.

WELL CONSTRUCTION



SAMPLE NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
		0.0 - 16.0' **Butte Quartz Monzonite** Orange-brown, oxidized Butte Quartz Monzonite, soft, decomposed, locally friable. Damp.
		16.0 - 20.0' **Butte Quartz Monzonite** Gray, hard, fine chips. Fresh surfaces, little oxidation. Dry, dusty.
		20.0 - 32.0' **Butte Quartz Monzonite** Mostly oxidized, brown-green-gray, medium hard. Dry and dusty to 22 feet. At 22 feet, begin water injection.
		32.0 - 42.0' **Butte Quartz Monzonite** Brown-yellow-orange iron stained cuttings (fine cuttings). No water at 42 feet.
		42.0 - 47.0' **Butte Quartz Monzonite** Soft, orange-brown, strongly oxidized, no fresh biotite, local orange clay chunks. Fine cuttings.
		47.0 - 58.0' **Butte Quartz Monzonite** Moderately oxidized, fresh biotite, brown-gray, harder, fine cuttings, weak iron staining.
		58.0 - 59.0' **Butte Quartz Monzonite** Fifty percent sticky, brown clay chunks, 50% Butte Quartz Monzonite chips. Difficult cuttings return from drill, soft.
		59.0 - 80.0' **Butte Quartz Monzonite** Fresh cuttings, little oxidation. 10 to 20 percent of cuttings larger chips (up to 1 inch diameter), gray with green chlorite alternation of select mineral sites within Butte Quartz Monzonite, minor iron. Moderately hard, locally more oxidized. No water at 62 feet.
		80.0 - 92.0' **Butte Quartz Monzonite** Similar to above, except less chlorite. At 82 feet, 12 inches of water in hole after sitting 11 minutes with air off.
		92.0 - 94.0' **Butte Quartz Monzonite** Similar to above, except more iron staining.
		94.0 - 110.0' **Butte Quartz Monzonite** Fresh cuttings, little oxidation. Moderate to traces of iron, gray and slightly green due to chlorite, small to medium cuttings (up to 1/2 inch diameter). At 102 feet, 12 inches of water after 11 minutes with air off.
		110.0 - 112.0' **Butte Quartz Monzonite** Mostly oxidized, orange-brown iron staining.
		112.0 - 142.0' **Butte Quartz Monzonite** Fresh cuttings, little oxidation. 10 to 30 percent, iron stained, semi-hard Butte Quartz Monzonite, gray fine to medium cuttings. At 122 feet, 2 gpm from cyclone. At 142 feet, 2 to 5 gpm from cyclone.

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW15-10

Date Hole Started: 8/3/15 | Date Hole Finished: 8/4/15

Client: Montana Resources
Project: Montana Resources YDTI
County: Silver Bow State: Montana
Property Owner: Montana Resources
Legal Description: T4N R7W NE1/4 SEC 32
Location Description: Just north of YD Pond

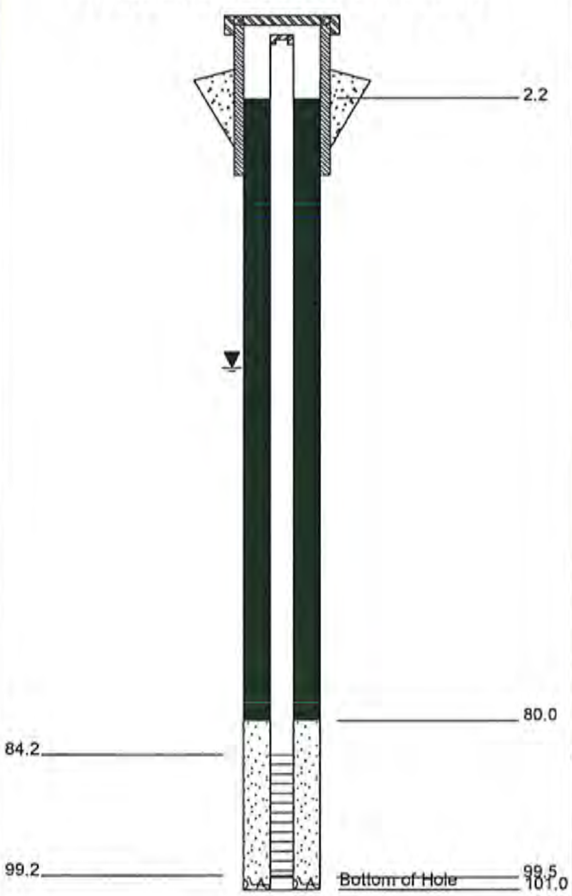
Recorded By: Michael Peet
Drilling Company: O'Keefe
Driller: Jerry Phillips
Drilling Method: Reverse Circulation
Drilling Fluids Used: Air, Water
Purpose of Hole: Groundwater Monitoring
Target Aquifer: Bedrock
Hole Diameter (in): 8"
Total Depth Drilled (ft): 101

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	+2.18 - 99.5
Surface Casing Used?	Y	8" Steel	+2.8 - 17.2
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	84 - 99
Sand Pack?	Y	10/20 Silica Sand	80 - 99.5
Annular Seal?	Y	3/8" Bentonite Chips	2.2 - 80
Surface Seal?	N		
DEVELOPMENT/SAMPLING			
Well Developed?	N		
Water Samples Taken?	N		
Boring Samples Taken?	Y	Cuttings	Every 10 feet

Northing: 149652.4088 Easting: 138920.3052
Static Water Level Below MP: 38.08 Surface Casing Height (ft): +2.80
Date: 8/5/15 Riser Height (ft): +2.18
MP Description: 2" PVC Casing Ground Surface Elevation (ft): 6366.8
MP Height Above or Below Ground (ft): +2.18 MP Elevation (ft): 6369

Remarks: Water was encountered at approximately 95 to 100 feet. Horizontal coordinates in mine coordinate system. Elevations in ACM Datum.

WELL CONSTRUCTION



SAMPLE NOTES

GRAPHICS

GEOLOGICAL DESCRIPTION

0.0 - 89.0' **Granoaplite**
Moderately hard, locally very hard granoaplite, weakly oxidized, minor FeOx; abundant fresh potassium feldspar. Light gray cuttings, small zones with gray-brown cuttings, local white clayey chunks (very minor). Dry, dusty.

At approximately 25 feet begin water injection.

No water at 61 feet or 81 feet with air and water injection shut off.

89.0 - 92.0' **Granoaplite**
Medium-brown cuttings, granoaplite with more iron staining than above, but still minor. Medium hard, fine cuttings.

92.0 - 97.0' **Granoaplite**
Dark brown cuttings and discharge water. Large chips up to 1 inch diameter, traces of iron clay chunks at 92 to 93 feet. Broken highly fractured ground caving behind bit/hammer. Lithology is between granoaplite and aplite.

97.0 - 101.0' **Granoaplite**
Large cuttings with weak to moderate iron staining. Brown-orange.

Hydrometrics, Inc.

Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW15-11

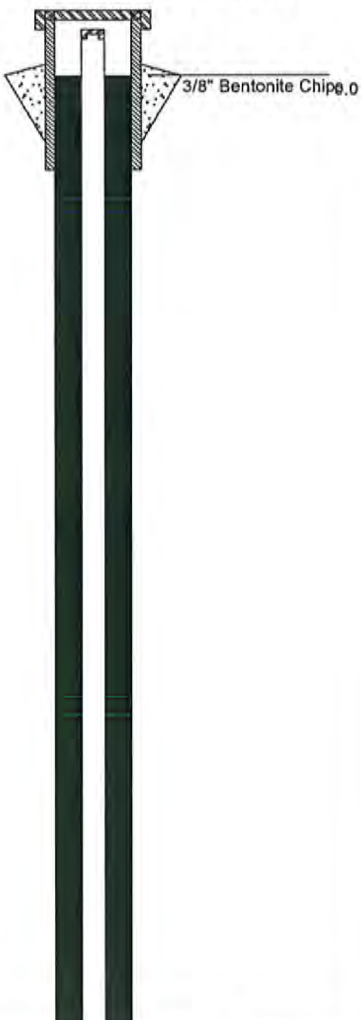
Date Hole Started: 8/4/15 | Date Hole Finished: 8/5/15

Client: Montana Resources	**WELL COMPLETION**	**Y/N**	**DESCRIPTION**	**INTERVAL**
Project: Montana Resources YDTI	Well Installed?	Y	4-inch, flush threaded, Sch 40, PVC	+2.0 - 201
County: Silver Bow State: Montana	Surface Casing Used?	Y	8" Steel	+2.6 - 29.5
Property Owner: Montana Resources	Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	160.5 - 200.5
Legal Description: T4N R7W NE1/4 SEC 32	Sand Pack?	Y	10/20 Silica Sand	154.5 - 200
Location Description: North of YDTI	Annular Seal?	Y	3/8" Bentonite Chips	0 - 154.5
	Surface Seal?	N		
Recorded By: Michael Peet	**DEVELOPMENT/SAMPLING**			
Drilling Company: O'Keefe	Well Developed?	N		
Driller: Jerry Phillips	Water Samples Taken?	N		
Drilling Method: Reverse Circulation	Boring Samples Taken?	Y	Cuttings	Every 10 feet

Drilling Fluids Used: Air, Water	Northing: 150603.0217	Easting: 140211.7817
Purpose of Hole: Groundwater Monitoring	Static Water Level Below MP: 159.37	Surface Casing Height (ft): +2.61
Target Aquifer: Bedrock	Date: 8/10/15	Riser Height (ft): +2.03
Hole Diameter (in): 8"	MP Description: 4" PVC	Ground Surface Elevation (ft): 6534.2
Total Depth Drilled (ft): 202	MP Height Above or Below Ground (ft): +2.03	MP Elevation (ft): 6536.3

Remarks: Trace water encountered at 122 feet, 1/2 gpm at 162 feet and 2.5 gpm at 202 feet. Well yields estimated by air lifting. Highly fractured rock at 155 to 202 feet. Horizontal coordinates in mine coordinate system. Elevations in ACM Datum.

WELL CONSTRUCTION	SAMPLE NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION



0.0 - 15.0' Granoaplite
Granoaplite, hard, light gray, fine cuttings, dry, dusty.

15.0 - 30.0' Aplite
Aplite (traces of biotite), highly fractured, large up to 1 inch diameter cuttings, minimal fines. Light gray-white. Drills quickly but cuttings are hard and competent. Dry, dusty.

30.0 - 30.5' Butte Quartz Monzonite
6 inch (?) orange-brown fracture, vein or fault. Traces of brick red-gougy material, transitions to tan-yellow then back to light gray. Dry, dusty.

30.5 - 45.0' Butte Quartz Monzonite
Soft, fine cuttings, medium gray. Local orange-brown silicic-limonitic vein clasts (42 to 45 feet). At approximately 35 feet begin water injection (to total depth).

45.0 - 77.0' Butte Quartz Monzonite
Soft, green-brown cuttings. Traces of less than 0.25-inch light colored gougy material. At 62 feet stop for 11 minutes with air off, no detectable water.

77.0 - 81.0' Butte Quartz Monzonite
Soft, entirely oxidized, orange-brown. 50 percent of cuttings are orange-red-brown hematitic-limonitic "clayey balls" up to 1 inch diameter. Poor return.

81.0 - 93.0' Butte Quartz Monzonite/Granoaplite
Butte Quartz Monzonite or granoaplite (?). Medium hard, partially oxidized, minor biotite, tan-gray cuttings. At 82 feet stop for 30 minutes with air off, no detectable water.

90.0 - 91.0' Slightly pink color due to iron.

93.0 - 94.0' Butte Quartz Monzonite
Fractured zone, large chips, light gray.

94.0 - 115.0' Butte Quartz Monzonite
Fresh cuttings, little oxidation. Moderately hard, small to medium cuttings. Local large chips at fractures, harder at 98 feet. At 102 feet, no water coming into hole.

111.0 - 112.0' Fractured zone, traces of iron staining.

115.0 - 137.0' Butte Quartz Monzonite
Large cuttings, many small fractured zones. Traces of red iron and white gougy

Continued Next Page

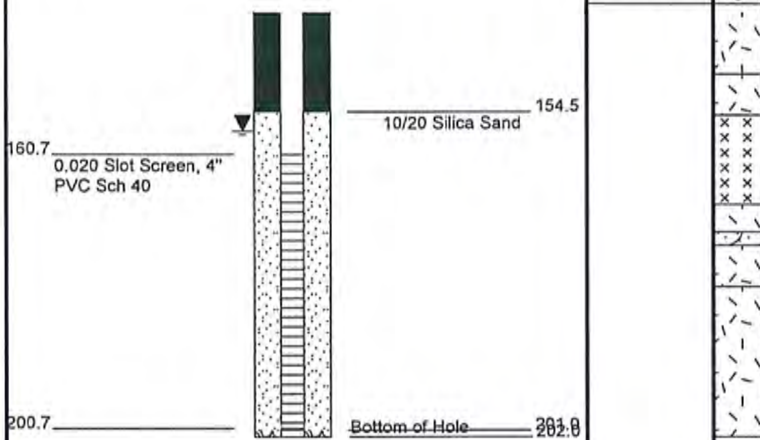
Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW15-11

Date Hole Started: 8/4/15 Date Hole Finished: 8/5/15

WELL CONSTRUCTION	SAMPLE NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION



material. At 122 feet, trace water from cyclone after sitting 13 minutes.

137.0 - 149.0' **Butte Quartz Monzonite**
Medium hard, fine cuttings. 60 to 80 percent reduced. At 142 feet, no detectable water after sitting 11 minutes.

149.0 - 155.0' **Butte Quartz Monzonite**
Similar to above, but mostly oxidized. At 154 feet, traces of red hematitic chips.

155.0 - 168.0' **Aplite**
Light gray-pink, hard but highly fractured. Drill torques occassionally. Large cuttings with very minor fines. At 162 feet, 1/2 gpm from cyclone.

168.0 - 172.0' **Butte Quartz Monzonite**
Medium to fine chips, gray-green.

172.0 - 174.0' **Granoaplite**
Minor iron and biotite.

174.0 - 180.0' **Butte Quartz Monzonite**
Dark (greater mafics?), highly fractured. Gray-green, large cuttings, reduced.

180.0 - 202.0' **Butte Quartz Monzonite**
Butte Quartz Monzonite with AP dikes/sills. Large cuttings, highly fractured, yet chips are hard and competent. Fresh surfaces, little oxidation. At 182 feet trace water from cyclone after sitting with air off for 26 minutes. 2.5 gpm at 202 feet from cyclone.

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW15-12

Date Hole Started: 8/10/15 Date Hole Finished: 8/10/15

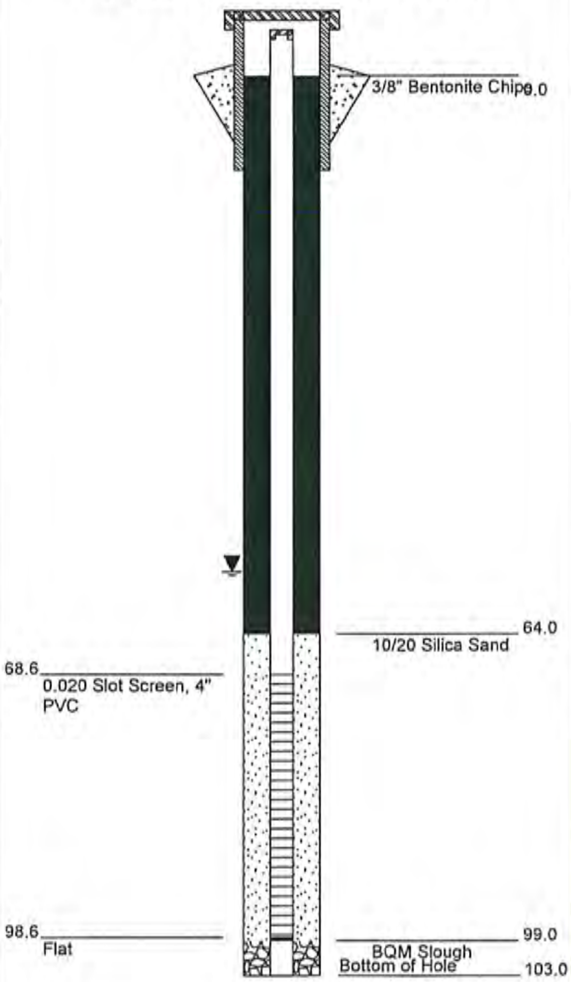
Client: Montana Resources
Project: Montana Resources YDTI
County: Silver Bow State: Montana
Property Owner: Montana Resources
Legal Description: T4N R7W NW1/4 SEC 33
Location Description: East of YDTI Barge and Drop Box
Recorded By: Michael Peet
Drilling Company: O'Keefe
Driller: Jerry Phillips
Drilling Method: Reverse Circulation
Drilling Fluids Used: Air, Water
Purpose of Hole: Groundwater Monitoring
Target Aquifer: Bedrock
Hole Diameter (in): 8"
Total Depth Drilled (ft): 103

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	Sch 40 PVC 4" Diameter	+2.50 - 99
Surface Casing Used?	Y	8" Steel	+3.00 - 17
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	68.5 - 98.5
Sand Pack?	Y	10/20 Silica Sand	64 - 99
Annular Seal?	Y	3/8" Bentonite Chips - Kwik Plug	0 - 64
Surface Seal?	N		
DEVELOPMENT/SAMPLING			
Well Developed?	N		
Water Samples Taken?	N		
Boring Samples Taken?	Y	Cuttings	Every 10 feet

Northing: 148433.935 Easting: 141332.298
Static Water Level Below MP: 59.37 Surface Casing Height (ft): +3.00
Date: 8/10/15 Riser Height (ft): +2.50
MP Description: 4" PVC Casing Ground Surface Elevation (ft): 6434
MP Height Above or Below Ground (ft): +2.50 MP Elevation (ft): 6436.18

Remarks: Water was encountered at 43 feet. Well yields estimated by air lifting. Horizontal coordinates in mine coordinate system. Elevations in ACM Datum.

WELL CONSTRUCTION



SAMPLE NOTES | GRAPHICS

GEOLOGICAL DESCRIPTION

0.0 - 30.0' Butte Quartz Monzonite
Hard to medium hard. Medium gray, locally gray-brown along fractures with iron. Dry, dusty 0 to 26 feet. From 26 to 30 feet moist. <0.5 gpm at 26 feet then moist again.

30.0 - 45.0' Butte Quartz Monzonite
Gray-green. Hard, fine cuttings. Dry, dusty at 30 to 40 feet. Damp at 40 to 43 feet.
4.5 gpm at 43 feet.
Begin water injection at 43 feet due to plugging.

45.0 - 51.0' Aplite
gray-tan-pinkish, fresh abundant Kspar, minor biotite. Local soft sericitic/argillic clayey chunks. Fine cuttings, hard, reduced. Fractured at lower contact (51 feet).

51.0 - 65.0' Butte Quartz Monzonite
Fine gray-green cuttings. Hard. Up to 15% aplite and pegmatite chips. Slightly oxidized (54 to 55 feet: greater aplite).
4.5 gpm at 63 feet.

65.0 - 85.0' Butte Quartz Monzonite
Gray-green, hard, mostly fine cuttings. Locally large 1 inch diameter chips.
4.5 gpm at 83 feet.

85.0 - 96.0' Butte Quartz Monzonite
Large cuttings from 85 to 86 feet, blue-gray, entirely reduced. Traces of py.
Fine cuttings at 86 to 96 feet.

96.0 - 103.0' Butte Quartz Monzonite
Gray-green. Hard, fine cuttings. Only traces of iron.
1.8 gpm at 103 feet.

STANDARD_REV4 K:\GINT\PROJECTS\12020 - MONITORING WELL LOGS.GPJ HYDHLN2.GDT 11/4/15

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW15-13

Date Hole Started: 8/11/15 Date Hole Finished: 8/11/15

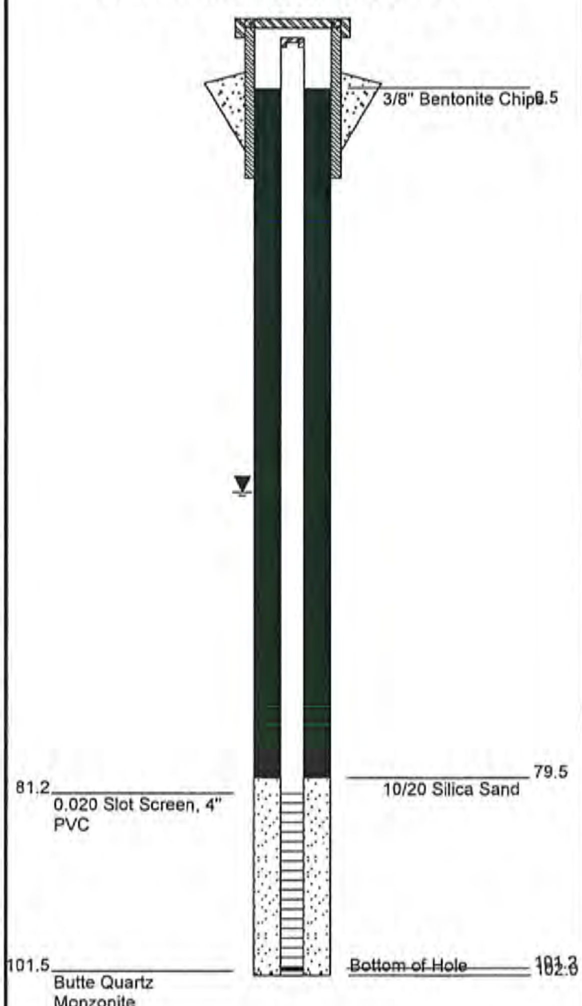
Client: Montana Resources
Project: Montana Resources YDTI
County: Silver Bow State: Montana
Property Owner: Montana Resources
Legal Description: T4N R7W SE1/4 SEC 32
Location Description: Between Well 15-12 and Well 12-05
Recorded By: Michael Peet
Drilling Company: O'Keefe
Driller: Jerry Phillips
Drilling Method: Reverse Circulation
Drilling Fluids Used: Air, Water
Purpose of Hole: Groundwater Monitoring
Target Aquifer: Bedrock Aquifer
Hole Diameter (in): 8"
Total Depth Drilled (ft): 102

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	Sch 40, 4" PVC	+2.50 - 101.5
Surface Casing Used?	Y	8" Steel	+3.00 - 19.5
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	81 - 101
Sand Pack?	Y	10/20 Silica Sand	79.5 - 101.5
Annular Seal?	Y	3/8" Bentonite Chips - Kwik Plug	+0.5 - 79.5
Surface Seal?	N		
DEVELOPMENT/SAMPLING			
Well Developed?	N		
Water Samples Taken?	N		
Boring Samples Taken?	Y	Chip Samples	Every 10 feet for reference

Northing: 146775.977 Easting: 140488.142
Static Water Level Below MP: 49.31 Surface Casing Height (ft): +3.00
Date: 8/11/15 Riser Height (ft): +2.50
MP Description: 4" PVC Ground Surface Elevation (ft): 6418.5
MP Height Above or Below Ground (ft): +2.50 MP Elevation (ft): 6420.83

Remarks: Water encountered at 40 feet. Water yields estimated by air lifting. Horizontal coordinates in mine coordinate system. Elevations in ACM Datum.

WELL CONSTRUCTION



SAMPLE NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
		0.0 - 25.0' Butte Quartz Monzonite Soft, rusty-brown fine cuttings, entirely oxidized. Dry, dusty.
		25.0 - 71.0' Butte Quartz Monzonite Brown-green-orange, abundant fines, soft, mostly oxidized. Slightly damp at 25 to 42 feet. Trace water at 42 feet. At 42 to 48 feet, wet. Inject water at 48 feet. At 48 feet and down, harder (medium hard) At 52 feet, fractured zone, large chips, return hose plugs. 12 gpm at 62 feet.
		71.0 - 83.0' Gouge Strongly oxidized vein and/or fault. Very soft, orange-brown cuttings, solid limonite chips, traces of orange-tan clays (soft - plastic) towards upper contact (toward 71 feet). Grades back into Butte Quartz Monzonite (iron deceases toward 83 feet). 9 gpm at 82 feet.
		83.0 - 102.0' Butte Quartz Monzonite Mostly oxidized. Traces of limonite chips, brown, slightly green fine cuttings. Fresh biotite. Medium hard drilling, locally softer at 88 to 95 feet. 7 gpm at 102 feet.

STANDARD_REV4 K:\GINT\PROJECTS\12020 - MONITORING WELL LOGS.GPJ HYDHLN2.GDT 11/4/15

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW16-01

Date Hole Started: 2/29/2016 Date Hole Finished: 4/4/2016

Client: Montana Resources
Project: Montana Resources YDTI
County: Silver Bow State: Montana
Property Owner: Montana Resources
Legal Description: T4N R8W SE1/4 SEC 36
Location Description: West Ridge-N of MW15-01 and E of Moulton Rd

Recorded By: Michael Peet
Drilling Company: O'Keefe
Driller: Jerry Phillips (RC), Shane Kraha (DR)
Drilling Method: RC and DR
Drilling Fluids Used: Air, Water
Purpose of Hole: Groundwater Monitoring
Target Aquifer: Fractured Bedrock
Hole Diameter (in): See Notes
Total Depth Drilled (ft): 520

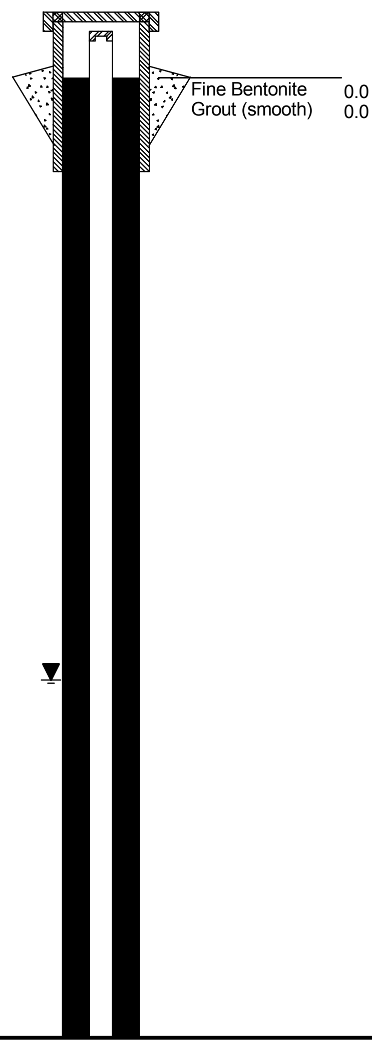
WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 80, PVC	+2.0 - 517
Surface Casing Used?	Y	10" Steel	+2.0 - 21.5
Screen/Perforations?	Y	0.010-inch slot, Sch 80, PVC	484.5 - 517
Sand Pack?	Y	10/20 Silica Sand	See Notes
Annular Seal?	Y	3/8" Bentonite Chips + Smooth Grout	0 - 475.5
Surface Seal?	Y	Fine Bentonite	0 - 10
DEVELOPMENT/SAMPLING			
Well Developed?	Y	2.5 - 3 gpm; air lifted	
Water Samples Taken?	N		
Boring Samples Taken?	Y	Cuttings samples taken every 10 feet	

Northing: 145547.76 Easting: 129461.41
Static Water Level Below MP: 158.7 Surface Casing Height (ft): +2.0
Date: 4/28/2016 Riser Height (ft): +1.9
MP Description: 2" PVC Ground Surface Elevation (ft): 6499.68
MP Height Above or Below Ground (ft): +1.9 MP Elevation (ft): 6501.59

Remarks: Gap in annular seal from approximately 180 to 280 feet. Smooth grout used for annular seal; mixed at 3 to 4 bgs for 70-gallon batch.

Hole Diameter: 0-17 feet - 13" diameter, 17-465 feet - 10" diameter, 465-520 feet - 6" diameter.
Screen Pack Interval: 479.5 to 517 - 10/20 sand, 475.5 to 479.5 - 100 mesh.

WELL CONSTRUCTION



GRAPHICS

GEOLOGICAL DESCRIPTION

0.0 - 23.0' **Butte Quartz Monzonite**
Grey-brown Butte Quartz Monzonite, fine cuttings, dusty, medium hard drilling.

23.0 - 25.0' **Butte Quartz Monzonite**
Softer, tan cuttings with traces of clayey brown-iron colored soft clay balls up to 1/2" diameter.

25.0 - 50.0' **Butte Quartz Monzonite**
Medium grey cuttings with minor iron, dusty, medium hard drilling. Begin water injection at 35 feet.

50.0 - 62.0' **Butte Quartz Monzonite**
Medium grey with minor iron chips, alternating harder and softer zones.

53 feet - driller says "broken-up" zone.

62.0 - 83.0' **Butte Quartz Monzonite**
Hard drilling, fine medium grey cuttings.

62 feet - small fractured zone, few 1-inch diameter chips from return.

83.0 - 102.0' **Butte Quartz Monzonite**
Hard drilling, fine grey-green cuttings.

102.0 - 104.0' **Butte Quartz Monzonite**
Softer, brown-green cuttings.

104.0 - 123.0' **Butte Quartz Monzonite**
Moderate to medium hard, grey-green-brown, medium size cuttings, minor iron.

116 feet - slightly softer drilling.

123.0 - 403.0' **Butte Quartz Monzonite**
Hard, grey-green, weak to moderate propylitic alteration, fine to medium chips from return; except for the following sub-intervals:

126 feet - traces of quartz vein fragments up to 1/2" diameter.

137 - 138 feet - softer, white argillic altd., more iron, traces of brown-orange clay balls.

142 - 144 feet - softer, fractured zone causing drill to jump.

166 - 170 feet - softer orange-brown, finer cuttings; oxidized fault gouge(?).

186 - 192 feet - medium hard, brown-green-orange cuttings.

207 - 211 feet - softer, more iron chips (from veinlets), olive green cuttings with more clay and fines.

222 - 225 feet - softer, somewhat fractured, several 1" chips from return.

233.5 - 235 feet - fractured zone; up to 1.5" diameter chips from return.

Continued Next Page

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW16-01

Date Hole Started: 2/29/2016 Date Hole Finished: 4/4/2016

WELL CONSTRUCTION

	Grout and Bentonite	280.0
	100 mesh Sand	475.5
	10/20 Silica Sand	479.5
484.5	0.010 Slot Screen	
517.0	Bottom of Hole	520.0

GRAPHICS

GEOLOGICAL DESCRIPTION

235 - 239 feet - softer.

241 - 243 feet - larger chips from return, more iron.

280 - 281 feet - softer.

334 - 336 feet - soft, white argillic altered Butte Quartz Monzonite; orange-brown cuttings, traces of iron veinlets.

337 feet - brief increase in water from cyclone, 1" diameter chips from return.

342 - 345 feet - driller says fractured zone "grabbing the bit."

351 - 354 feet - soft drilling, mostly fine cuttings with a few 3/4" diameter chips.

355 - 365 feet - highly fractured; abundant 1/2 to 1" diameter chips from return, traces of calcite veinlets (flat 1/16" chips), more iron. Drill return plugs up.

363 feet - brown clayey fines in cuttings.

376 feet - softer, traces of tabular calcite vein chips.

383 - 384 feet - light orange-tan cuttings, 20% orange-brown iron chips, light "epidote green" staining of feldspars.

377 - 401 feet - traces of small, white, clayey chunks, likely sericite.

403.0 - 470.0' **Butte Quartz Monzonite - Shear Zone**
Soft, altered, sheared Butte Quartz Monzonite; light grey-green-blue, more fines and clays, abundant white sericite-clay chunks, bluish-green chlorite and sericite, very minor iron, soft drilling.

421 - 423 feet - dark green chlorite seams at 421 feet, then light grey to white phyllic altered Butte Quart Monzonite, mostly quartz.

423 - 436 feet - return to green argillic/green sericite/chlorite altered Butte Quartz Monzonite.

436 feet - rusty quartz vein fragments.

455 - 456 feet - 30% dark grey quartz vein fragments with minor diss. pyrite.

464 - 466 feet - 30% dark grey quartz vein fragments with minor diss. pyrite.

470.0 - 520.0' **Butte Quartz Monzonite**
More competent (harder) Butte Quartz Monzonite, less fines and clays, weak to moderate propylitic alteration, green plagioclase, highly fractured rock causing drill bit to jump and torque-up regularly throughout interval, large chips from return with about one third at 1/4 to 1 1/2 inch in diameter, with one fragment 3 inches long recovered from cyclone.

470 feet - Drill jumps in fractured zone (competent Butte Quartz Monzonite chips, but fractured).

Hydrometrics, Inc.

Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW16-02D

Date Hole Started: 4/25/2016 Date Hole Finished: 6/9/2016

Client: Montana Resources
Project: Montana Resources YDTI
County: Silver Bow State: Montana
Property Owner: Montana Resources
Legal Description: T4N R8W, SE1/4 SEC 36
Location Description: Approx. 280 feet east of MW16-01, East of Moulton Rd

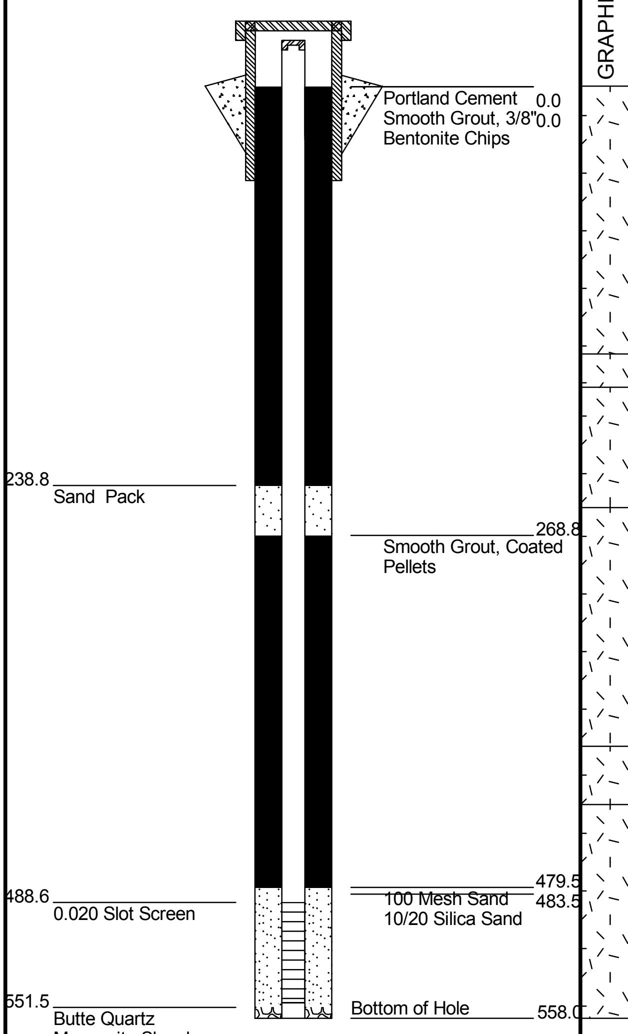
Recorded By: Michael Peet
Drilling Company: O'Keefe
Driller: J. Phillips, Shane Kraha
Drilling Method: Rotary Hammer and Tricone
Drilling Fluids Used: Air, Water, Foam, Polymer
Purpose of Hole: Groundwater Monitoring
Target Aquifer: Deep Fractured BQM
Hole Diameter (in): See Notes
Total Depth Drilled (ft): 558

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	6-inch, flush threaded, Sch 80, PVC	+1.4 to 549.0
Surface Casing Used?	Y	16" Steel	+2.5 to 29
Screen/Perforations?	Y	0.020-inch slot, Sch 80 PVC	489 - 549
Sand Pack?	Y	10/20 Silica Sand, 100 mesh sand	483 - 551
Annular Seal?	Y	Smooth grout, coated pellets, polyswell	0 - 483
Surface Seal?	Y	Portland Cement	0 - 29
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Surge/Pump	
Water Samples Taken?	N		
Boring Samples Taken?	Y	Cuttings collected every 10 feet.	

Northing: 145539.9 Easting: 129716.8
Static Water Level Below MP:
Date:
MP Description: 6" PVC
MP Height Above or Below Ground (ft): +1.5
Surface Casing Height (ft): +2.5
Riser Height (ft): +1.5
Ground Surface Elevation (ft): 6497.88
MP Elevation (ft): 6499.41

Remarks: Completed as nested well pair with MW16-02S. Borehole completed to 558 feet, slough infill to 551 feet. Borehole diameter 15 inches from 0 to 510 feet; 12 inches from 510 to 558 feet. 10/20 silica sand from 551 to 486 feet, 100 mesh sand 486 to 483 feet. Bentonite seal included smooth grout and bentonite pellets with polyswell from 297 to 351 feet. Horizontal coordinates in mine grid system. Elevations in Anaconda Datum (approximately 58 feet higher than USGS Datum).

WELL CONSTRUCTION



GEOLOGICAL DESCRIPTION

0.0 - 160.0' **Butte Quartz Monzonite**
Fine cuttings, brown-gray, medium hard drilling, injecting water.

23 to 80 feet: most biotite weathered to vermiculite/phlogopite.
90 to 160 feet: medium size cuttings.

160.0 - 180.0' **Butte Quartz Monzonite**
Medium cuttings, gray-brown, 10 to 20% orange-yellow-brown iron stained chips.

174 to 177 feet: brown-tan slightly orange colored cuttings.

180.0 - 252.0' **Butte Quartz Monzonite**
Medium cuttings, medium gray in color, minor iron.

193 to 200 feet: fractured Butte Quartz Monzonite; sloughing after trip out.
200 to 222 feet: more iron; approximately 5 to 10% yellow-orange stained chips.
202 to 204 feet: brown with more iron.
224 to 252 feet: harder, slower drilling.

252.0 - 395.0' **Butte Quartz Monzonite**
Fine to medium cuttings, minor iron, fresh biotite, gray-brown-green overall.

292 to 302 and 312 to 324 feet: approximately 5% orange iron stained Butte Quartz Monzonite chips.
370 feet: increase in water from return, drill torques-up occasionally indicating fracturing, increasing iron and white platy sericite/clay chips with depth.

395.0 - 430.0' **Butte Quartz Monzonite**
Harder; gray cuttings, weak propylitic alteration. Significant increase in yield at 400 feet.

430.0 - 558.0' **Butte Quartz Monzonite**
Fractured Butte Quartz Monzonite; drill torques-up and jumps regularly, platy, white chips of sericite or clays from fracture surfaces constitute up to 10% of cuttings, brown-orange iron chips increase with depth (up to 15%), fine to medium cuttings, local traces of quartz and calcite vein fragments.

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Monitor Well Log

Hole Name: MW16-02S

Date Hole Started: 4/25/2016 Date Hole Finished: 6/9/2016

Client: Montana Resources
Project: Montana Resources YDTI
County: Silver Bow State: Montana
Property Owner: Montana Resources
Legal Description: T4N R8W SE1/4 SEC 36
Location Description: Approx. 280 feet east of MW16-01, East of Moulton Rd

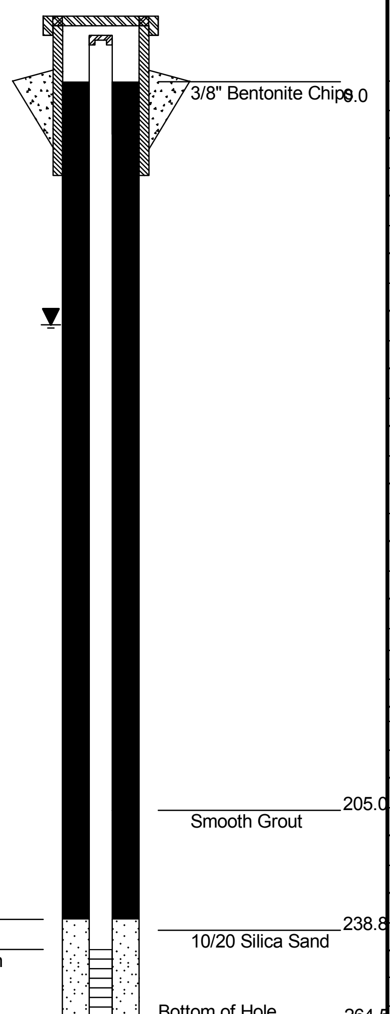
Recorded By: Michael Peet
Drilling Company: O'Keefe
Driller: J. Phillips, Shane Kraha
Drilling Method: Rotary Hammer
Drilling Fluids Used: Air, Water, Foam, Polymer
Purpose of Hole: Groundwater Monitoring
Target Aquifer: Upper Beckrock System
Hole Diameter (in): 15
Total Depth Drilled (ft): 264.5

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	+1.3 to 264
Surface Casing Used?	Y	16" Steel	
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	244 - 264
Sand Pack?	Y	10/20 Silica Sand, 100-Mesh Sand	236 - 269
Annular Seal?	Y	Smooth Grout, 3/8" Bentonite Chips	0 - 236
Surface Seal?	Y	Portland Cement	0 - 29
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Surge/Pump	
Water Samples Taken?	N		
Boring Samples Taken?	Y	Cuttings collected every 10 feet.	

Northing: 145539.8 Easting: 129717.5
Static Water Level Below MP: 69.70 Surface Casing Height (ft): +2.5
Date: 6/28/2016 Riser Height (ft): +1.45
MP Description: 2" PVC Riser Ground Surface Elevation (ft): 6497.88
MP Height Above or Below Ground (ft): +1.3 MP Elevation (ft): 6499.33

Remarks: Completed as nested well pair with MW16-02D. 10/20 silica sand from 239 to 269 feet, 100 mesh from 236 to 239 feet. Horizontal coordinates in mine grid system. Elevations in Anaconda Datum (approximately 58 feet higher than USGS Datum).

WELL CONSTRUCTION



GEOLOGICAL DESCRIPTION

0.0 - 160.0' **Butte Quartz Monzonite**
Fine cuttings, brown-gray, medium hard drilling, injecting water.

23 to 80 feet: most biotite weathered to vermiculite/phlogopite.
90 to 160 feet: medium size cuttings.

160.0 - 180.0' **Butte Quartz Monzonite**
Medium cuttings, gray-brown, 10 to 20% orange-yellow-brown iron stained chips.

174 to 177 feet: brown-tan slightly orange colored cuttings.

180.0 - 252.0' **Butte Quartz Monzonite**
Medium cuttings, medium gray in color, minor iron.

193 to 200 feet: fractured Butte Quartz Monzonite; sloughing after trip out.
200 to 222 feet: more iron; approximately 5 to 10% yellow-orange stained chips.
202 to 204 feet: brown with more iron.
224 to 252 feet: harder, slower drilling.

252.0 - 264.5' **Butte Quartz Monzonite**
Fine to medium cuttings, minor iron, fresh biotite, gray-brown-green overall.

APPENDIX B

GROUNDWATER LEVEL DATA

TABLE B-1. WEST RIDGE MONITORING WELL DEPTHS TO GROUNDWATER

Well	Measuring Point Elev.	Screened Interval feet bgs	Depth to Water													
			9/12/12	9/25/12	10/1/12	10/11/12	11/1/12	11/12/12	11/19/12	11/26/12	12/3/12	12/10/12	12/17/12	12/24/12	12/31/12	1/8/13
MW 12-11	6521.41	145-195	50.09	50.11	50.27	50.35	50.81	51.08	51.22	51.3	51.38	51.36	51.27	51.41	51.68	51.80
MW 12-12	6475.87	160-195	42.93	43.32	43.46	43.71	46.36	44.82	44.86	44.87	45.19	45.04	45.02	45.23	45.49	45.72
MW 12-13	6490.28	145-195	26.15	26.65	26.95	27.46	28.68	29.1	29.33	29.53	29.52	29.90	29.99	32.10	30.51	30.72
MW 12-14	6476.47	100-150	38.23	38.94	38.81	39.14	40.11	40.32	40.43	40.8	40.95	41.08	41.02	41.21	41.41	41.54
MW 12-15	6518.91	150-200	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW 12-16	6487.58	140-190	na	NM	NM	NM	NM	NM	NM	NM	NM	93.31	93.71	94.07	94.43	94.65
MW 12-17	6472.97	155-195	na	NM	NM	NM	NM	NM	NM	NM	NM	NM	35.89	36.00	36.21	36.31
MW 12-18	6472.65	80-115	na	NM	NM	NM	NM	NM	NM	NM	NM	NM	37.13	37.18	37.34	37.50
MW 15-01	6504.13	182-222	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW 15-02	6483.34	147-197	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW 15-03	6487.41	345-385	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW 15-04	6435.98	170-220	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW 15-05	6468.72	240-290	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW 15-06	6468.97	350-400	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW 15-07	6464.65	162.5-202.5	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW 15-08	6464.57	81.5-101.5	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW 15-09	6455.25	92-142	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW 15-10	6369.00	84-99	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW 15-11	6536.30	161-201	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW 15-12	6436.18	68.5-98.5	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW 15-13	6420.83	81-101	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW 16-01	6501.53	485-517	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW 16-02S	6499.33	489-549	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW 16-02D	6499.41	244-264	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
516409	6717.30	Open Hole	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
516410	6716.83	Open Hole	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
514409	6700.14	Open Hole	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM

NM - Not Measured
All measurements in feet

TABLE B-1. WEST RIDGE MONITORING WELL DEPTHS TO GROUNDWATER

Well	Measuring Point Elev.	Screened Interval feet bgs	Depth to Water															
			7/2/13	7/9/13	8/20/13	9/16/13	10/16/13	11/11/13	12/11/13	10/8/14	8/18/15	9/18/15	10/8/15	10/15/15	10/22/15	10/27/15	11/9/15	11/17/15
MW 12-11	6521.41	145-195	54.49	54.9	55.31	55.75	56.35	56.75	57.06	55.96	57.98	58.15	58.32	58.36	58.36	58.35	58.57	58.71
MW 12-12	6475.87	160-195	49.35	49.32	50.20	50.46	51.37	51.28	52.51	50.4	47.88	48.55	48.91	48.99	49.07	48.68	49.38	49.44
MW 12-13	6490.28	145-195	31.70	31.8	32.20	32.80	33.50	33.85	34.31	33.09	22.58	24.22	25.15	25.37	25.58	25.31	26.27	26.59
MW 12-14	6476.47	100-150	44.3	44.1	44.44	45.89	45.43	45.72	46.15	45.19	40.95	41.92	42.45	42.62	42.75	42.85	43.20	43.39
MW 12-15	6518.91	150-200	27.38	29.05	28.4	30.20	30.22	30.61	30.98	29.13	33.82	34.15	34.33	34.40	34.43	33.84	34.66	34.73
MW 12-16	6487.58	140-190	99.33	99.6	100.52	101.12	101.93	102.63	103.23	101.75	108.77	108.69	108.70	108.68	108.47	107.71	106.37	105.44
MW 12-17	6472.97	155-195	38.55	38.65	39.02	39.35	39.82	40.17	40.50	39.64	37.88	38.30	38.58	38.67	38.74	38.76	39.01	39.10
MW 12-18	6472.65	80-115	39.02	39.15	39.75	40.30	40.88	41.27	41.65	40.72	38.18	38.57	38.87	38.98	39.00	39.17	39.32	39.43
MW 15-01	6504.13	182-222	NM	NM	NM	NM	NM	NM	NM	NM	60.03	60.20	60.30	60.36	60.41	60.46	60.45	60.52
MW 15-02	6483.34	147-197	NM	NM	NM	NM	NM	NM	NM	NM	76.43	75.51	75.32	75.32	75.24	75.23	73.90	72.15
MW 15-03	6487.41	345-385	NM	NM	NM	NM	NM	NM	NM	NM	108.30	108.06	108.18	108.10	107.84	106.60	105.78	102.94
MW 15-04	6435.98	170-220	NM	NM	NM	NM	NM	NM	NM	NM	63.56	63.91	64.10	64.13	64.07	63.94	63.81	63.95
MW 15-05	6468.72	240-290	NM	NM	NM	NM	NM	NM	NM	NM	34.44	34.94	35.21	35.24	35.27	35.36	35.40	35.56
MW 15-06	6468.97	350-400	NM	NM	NM	NM	NM	NM	NM	NM	40.42	40.94	41.21	41.23	41.26	41.25	41.32	41.43
MW 15-07	6464.65	162.5-202.5	NM	NM	NM	NM	NM	NM	NM	NM	74.18	74.38	74.61	74.61	74.48	73.65	71.48	69.90
MW 15-08	6464.57	81.5-101.5	NM	NM	NM	NM	NM	NM	NM	NM	60.04	60.96	61.33	61.44	61.54	61.60	62.01	62.03
MW 15-09	6455.25	92-142	NM	NM	NM	NM	NM	NM	NM	NM	43.57	43.94	44.28	44.36	44.47	44.53	44.90	44.95
MW 15-10	6369.00	84-99	NM	NM	NM	NM	NM	NM	NM	NM	37.42	37.20	36.88	36.71	36.45	36.42	35.92	35.94
MW 15-11	6536.30	161-201	NM	NM	NM	NM	NM	NM	NM	NM	159.48	159.63	159.66	159.66	159.66	159.69	159.66	159.66
MW 15-12	6436.18	68.5-98.5	NM	NM	NM	NM	NM	NM	NM	NM	57.52	57.70	58.11	58.21	58.28	58.36	58.43	58.44
MW 15-13	6420.83	81-101	NM	NM	NM	NM	NM	NM	NM	NM	51.54	51.55	51.45	51.34	51.25	51.18	54.91	54.49
MW 16-01	6501.53	485-517	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW 16-02S	6499.33	489-549	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW 16-02D	6499.41	244-264	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
516409	6717.30	Open Hole	NM	NM	NM	NM	NM	NM	NM	NM	118.50	118.88	119.06	119.17	119.19	119.28	119.36	119.48
516410	6716.83	Open Hole	NM	NM	NM	NM	NM	NM	NM	NM	125.30	128.54	128.81	128.88	128.90	129.00	129.04	129.20
514409	6700.14	Open Hole	NM	NM	NM	NM	NM	NM	NM	NM	121.92	133.95	134.15	134.33	134.45	134.53	134.76	134.84

NM - Not Measured
All measurements in feet

TABLE B-1. WEST RIDGE MONITORING WELL DEPTHS TO GROUNDWATER

Well	Measuring Point Elev.	Screened Interval feet bgs	Depth to Water														
			12/2/15	1/8/16	2/23/16	3/15/16	3/30/16	4/18/16	5/2/16	5/9/16	5/17/16	5/23/16	6/1/16	6/6/16	6/16/16	6/21/16	7/1/16
MW 12-11	6521.41	145-195	58.91	59.32	59.81	60.05	60.18	60.35	60.19	59.94	60.01	59.88	59.71	59.52	59.03	58.96	58.80
MW 12-12	6475.87	160-195	49.66	50.21	50.65	50.48	50.28	49.62	48.50	47.97	47.97	47.75	47.10	46.53	45.89	45.41	45.97
MW 12-13	6490.28	145-195	27.16	28.32	29.64	29.71	28.89	23.48	18.48	16.61	16.00	15.20	13.28	12.55	12.20	12.34	13.22
MW 12-14	6476.47	100-150	43.79	44.68	45.56	45.55	45.32	42.24	40.00	39.51	39.51	39.16	37.57	36.70	35.74	35.72	35.83
MW 12-15	6518.91	150-200	34.87	35.16	35.52	35.70	35.78	35.68	35.59	35.52	35.54	35.51	35.45	35.34	35.01	34.95	35.05
MW 12-16	6487.58	140-190	104.64	106.75	107.78	108.16	108.34	108.58	108.59	108.09	107.78	107.33	106.94	106.71	106.12	105.92	105.52
MW 12-17	6472.97	155-195	39.34	39.81	40.43	40.66	40.68	40.11	39.42	39.09	38.92	38.72	38.38	38.11	37.63	37.58	37.26
MW 12-18	6472.65	80-115	39.68	40.23	40.88	40.97	40.83	39.10	38.58	38.27	38.14	37.88	37.19	36.92	36.34	36.20	35.96
MW 15-01	6504.13	182-222	60.63	61.03	61.35	64.18	65.92	63.73	69.48	74.68	73.12	72.23	72.02	71.23	73.95	73.28	71.90
MW 15-02	6483.34	147-197	73.30	74.38	75.04	74.47	74.32	73.51	72.54	72.32	72.29	71.95	70.98	70.56	69.86	69.68	69.41
MW 15-03	6487.41	345-385	103.13	109.27	110.31	110.47	110.57	110.67	110.52	110.04	109.97	109.58	109.32	109.02	108.47	108.65	108.22
MW 15-04	6435.98	170-220	63.65	63.82	64.19	64.28	64.33	64.27	61.31	53.04	51.98	51.57	51.30	50.48	47.95	48.30	48.84
MW 15-05	6468.72	240-290	35.62	36.04	36.23	36.27	36.15	35.41	34.84	34.54	34.53	34.37	33.87	33.67	33.26	33.25	33.05
MW 15-06	6468.97	350-400	41.59	41.86	42.25	42.21	42.16	42.27	41.18	40.63	40.67	40.41	40.19	39.88	39.39	39.34	39.23
MW 15-07	6464.65	162.5-202.5	69.87	74.18	75.17	75.67	75.64	75.09	74.22	73.91	73.97	73.80	73.28	72.79	72.11	71.94	72.05
MW 15-08	6464.57	81.5-101.5	61.96	62.95	63.62	64.15	63.96	62.88	61.91	61.74	61.68	61.64	60.87	60.24	59.41	59.08	59.19
MW 15-09	6455.25	92-142	45.17	NM	NM	NM	NM	46.44	45.76	45.40	45.18	45.02	44.69	44.32	43.63	43.47	43.47
MW 15-10	6369.00	84-99	NM	NM	NM	NM	NM	31.86	31.51	NM	31.22	30.85	NM	NM	NM	30.55	30.55
MW 15-11	6536.30	161-201	NM	NM	NM	NM	NM	159.68	159.62	NM	159.64	159.66	NM	NM	NM	159.40	159.47
MW 15-12	6436.18	68.5-98.5	NM	NM	NM	NM	NM	58.13	58.40	NM	58.88	58.74	58.26	NM	NM	58.59	58.69
MW 15-13	6420.83	81-101	NM	NM	NM	NM	NM	51.94	52.52	NM	52.27	52.26	52.26	NM	NM	51.97	53.22
MW 16-01	6501.53	485-517	NM	NM	NM	NM	NM	158.7	164.36	106.56	86.18	90.18	99.63	80.07	103.03	110.16	113.66
MW 16-02S	6499.33	489-549	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	71.45	69.00
MW 16-02D	6499.41	244-264	NM	NM	NM	NM	NM	NM	NM	NM	73.5	70	71.5	68	NM	NM	112.27
516409	6717.30	Open Hole	NM	NM	NM	NM	NM	121.19	121.05	NM	120.84	120.73	NM	NM	NM	119.92	119.65
516410	6716.83	Open Hole	NM	NM	NM	NM	NM	129.75	129.79	NM	129.77	129.76	NM	NM	NM	129.67	129.49
514409	6700.14	Open Hole	NM	NM	NM	NM	NM	131.72	122.46	NM	126.00	124.79	NM	NM	NM	113.24	112.23

NM - Not Measured
All measurements in feet

TABLE B-1. WEST RIDGE MONITORING WELL DEPTHS TO GROUNDWATER

Well	Measuring Point Elev.	Screened Interval feet bgs	Depth to Water														
			7/8/16	7/15/16	7/28/16	8/11/16	8/23/16	9/8/16	9/26/16	10/26/16	11/22/16	3/10/2017	4/12/17	4/28/17	5/15/17	5/29/17	6/16/17
MW 12-11	6521.41	145-195	58.64	58.54	58.45	58.49	58.33	58.28	58.41	59.49	58.90	60.17	60.27	59.97	59.25	57.73	54.90
MW 12-12	6475.87	160-195	45.67	45.77	45.98	46.08	46.51	46.74	47.19	47.22	48.10	49.59	46.23	45.26	44.13	40.08	37.62
MW 12-13	6490.28	145-195	13.68	14.38	15.5	16.63	17.62	19	20.51	22.54	23.24	27.15	19.10	16.40	14.33	9.95	8.65
MW 12-14	6476.47	100-150	35.94	36.19	36.68	37.23	37.75	38.4	39.19	40.25	46.98	43.67	36.20	36.60	33.26	25.06	21.74
MW 12-15	6518.91	150-200	34.90	34.79	34.71	34.59	35.75	35.84	36.03	36.23	36.53	37.52	37.14	37.15	36.80	35.78	33.55
MW 12-16	6487.58	140-190	105.15	104.84	104.37	104.02	103.51	102.92	102.60	102.23	101.83	101.83	101.89	101.64	101.16	100.88	99.97
MW 12-17	6472.97	155-195	37.08	37.00	36.89	36.88	36.89	37.04	37.39	38.14	38.20	39.62	38.54	37.83	36.90	34.97	32.05
MW 12-18	6472.65	80-115	35.88	35.86	35.92	36.15	36.35	36.71	37.20	37.72	38.17	39.83	36.55	35.97	34.95	31.43	25.45
MW 15-01	6504.13	182-222	71.30	70.79	70.12	69.61	69.48	69.79	69.80	69.35	69.15	68.60	67.42	66.82	65.98	63.49	60.78
MW 15-02	6483.34	147-197	69.27	69.22	69.12	69.16	69.24	69.44	69.78	70.65	70.92	72.96	70.25	68.94	67.56	61.90	56.38
MW 15-03	6487.41	345-385	107.77	107.62	107.12	106.82	106.33	105.80	105.80	104.69	105.28	105.08	104.62	104.28	103.80	103.24	102.12
MW 15-04	6435.98	170-220	49.24	49.80	50.75	51.50	48.98	49.64	50.94	52.05	52.86	55.28	51.55	50.15	49.12	46.32	44.35
MW 15-05	6468.72	240-290	33.04	33.07	34.13	33.22	33.34	33.59	33.95	34.21	34.56	35.63	33.92	33.23	32.37	29.10	26.67
MW 15-06	6468.97	350-400	39.03	39.08	39.15	39.23	39.52	39.71	40.09	40.24	40.53	41.43	39.95	39.33	38.35	36.15	33.87
MW 15-07	6464.65	162.5-202.5	71.78	71.77	71.72	71.78	71.77	71.8	72.06	72.93	72.33	73.04	70.94	70.27	69.37	65.69	62.85
MW 15-08	6464.57	81.5-101.5	59.01	59.06	59.29	59.75	60.11	60.64	61.18	61.81	62.00	63.70	60.25	59.33	58.10	51.45	46.93
MW 15-09	6455.25	92-142	43.25	43.14	43.08	43.12	43.2	NM	43.70	45.05	44.85	NM	46.20	45.08	43.60	40.60	38.07
MW 15-10	6369.00	84-99	30.60	30.65	30.66	30.80	NM	NM	30.68	30.04	29.55	NM	NM	NM	NM	NM	NM
MW 15-11	6536.30	161-201	159.52	159.53	159.62	159.70	NM	NM	159.90	159.94	159.91	NM	NM	NM	NM	NM	NM
MW 15-12	6436.18	68.5-98.5	58.71	58.67	58.52	58.35	NM	NM	58.30	58.26	58.40	NM	58.34	57.97	58.33	NM	55.40
MW 15-13	6420.83	81-101	53.38	53.59	53.95	54.37	NM	NM	55.19	55.16	55.62	NM	52.58	51.98	51.03	NM	46.92
MW 16-01	6501.53	485-517	118.95	122.79	161.70	138.76	262.21	287.49	242.55	171.01	157.40	132.86	129.28	127.77	126.08	124.87	122.94
MW 16-02S	6499.33	489-549	67.98	67.17	67.40	65.87	NM	67.07	65.92	65.38	65.13	64.43	63.25	62.63	61.78	58.88	56.07
MW 16-02D	6499.41	244-264	117.42	121.25	161.01	136.18	404.07	284.97	239.71	168.41	154.63	129.84	126.19	124.57	122.85	121.54	119.52
516409	6717.30	Open Hole	119.48	119.39	119.26	119.18	NM	NM	119.09	119.42	119.73	NM	NM	NM	NM	NM	NM
516410	6716.83	Open Hole	129.32	129.22	129.07	128.97	NM	NM	129.08	129.23	129.46	NM	NM	NM	NM	NM	NM
514409	6700.14	Open Hole	111.60	111.37	111.65	111.84	NM	NM	112.75	114.39	117.03	NM	NM	NM	NM	NM	NM

NM - Not Measured
All measurements in feet

TABLE B-2. WEST RIDGE MONITORING WELL GROUNDWATER ELEVATIONS

Well	Measuring Point Elev.	Screened Interval feet bgs	Groundwater Elevation																
			9/12/12	9/25/12	10/1/12	10/11/12	11/1/12	11/12/12	11/19/12	11/26/12	12/3/12	12/10/12	12/17/12	12/24/12	12/31/12	1/8/13	7/2/13	7/9/13	8/20/13
MW 12-11	6521.41	145-195	6471.32	6471.30	6471.14	6471.06	6470.60	6470.33	6470.19	6470.11	6470.03	6470.05	6470.14	6470.00	6469.73	6469.61	6466.92	6466.51	6466.10
MW 12-12	6475.87	160-195	6432.94	6432.55	6432.41	6432.16	6429.51	6431.05	6431.01	6431.00	6430.68	6430.83	6430.85	6430.64	6430.38	6430.15	6426.52	6426.55	6425.67
MW 12-13	6490.28	145-195	6464.13	6463.63	6463.33	6462.82	6461.60	6461.18	6460.95	6460.75	6460.76	6460.38	6460.29	6458.18	6459.77	6459.56	6458.58	6458.48	6458.08
MW 12-14	6476.47	100-150	6438.24	6437.53	6437.66	6437.33	6436.36	6436.15	6436.04	6435.67	6435.52	6435.39	6435.45	6435.26	6435.06	6434.93	6432.17	6432.37	6432.03
MW 12-15	6518.91	150-200	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	6491.53	6489.86	6490.51
MW 12-16	6487.58	140-190	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	6393.87	6393.51	6393.15	6392.93	6388.25	6387.98	6387.06
MW 12-17	6472.97	155-195	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	6437.08	6436.97	6436.76	6436.66	6434.42	6434.32	6433.95
MW 12-18	6472.65	80-115	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	6435.52	6435.47	6435.31	6435.15	6433.63	6433.50	6432.90
MW 15-01	6504.13	182-222	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
MW 15-02	6483.34	147-197	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
MW 15-03	6487.41	345-385	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
MW 15-04	6435.98	170-220	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
MW 15-05	6468.72	240-290	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
MW 15-06	6468.97	350-400	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
MW 15-07	6464.65	162.5-202.5	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
MW 15-08	6464.57	81.5-101.5	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
MW 15-09	6455.25	92-142	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
MW 15-10	6369.00	84-99	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
MW 15-11	6536.30	161-201	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
MW 15-12	6436.18	68.5-98.5	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
MW 15-13	6420.83	81-101	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
MW 16-01	6501.53	485-517	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
MW 16-02S	6499.33	489-549	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
MW 16-02D	6499.41	244-264	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
516409	6717.30	Open Hole	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
516410	6716.83	Open Hole	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
514409	6700.14	Open Hole	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm

NM - Not Measured (well not completed yet)
All measurements in feet
All elevations ACM Datum (USGS=ACM-57.15 ft)

TABLE B-2. WEST RIDGE MONITORING WELL GROUNDWATER ELEVATIONS

Well	Measuring Point Elev.	Screened Interval feet bgs	Groundwater Elevation																
			9/16/13	10/16/13	11/11/13	12/11/13	10/8/14	6/5/15	8/18/15	9/18/15	10/8/15	10/15/15	10/22/15	10/27/15	11/9/15	11/17/15	12/2/15	1/8/16	2/23/16
MW 12-11	6521.41	145-195	6465.66	6465.06	6464.66	6464.35	6465.45	6,462.72	6463.43	6463.26	6463.09	6463.05	6463.05	6463.06	6462.84	6462.70	6462.50	6462.09	6461.60
MW 12-12	6475.87	160-195	6425.41	6424.50	6424.59	6423.36	6425.47	6,428.32	6427.99	6427.32	6426.96	6426.88	6426.80	6427.19	6426.49	6426.43	6426.21	6425.66	6425.22
MW 12-13	6490.28	145-195	6457.48	6456.78	6456.43	6455.97	6457.19	6,470.87	6467.70	6466.06	6465.13	6464.91	6464.70	6464.97	6464.01	6463.69	6463.12	6461.96	6460.64
MW 12-14	6476.47	100-150	6430.58	6431.04	6430.75	6430.32	6431.28	6,436.05	6435.52	6434.55	6434.02	6433.85	6433.72	6433.62	6433.27	6433.08	6432.68	6431.79	6430.91
MW 12-15	6518.91	150-200	6488.71	6488.69	6488.30	6487.93	6489.78	6,485.03	6485.09	6484.76	6484.58	6484.51	6484.48	6485.07	6484.25	6484.18	6484.04	6483.75	6483.39
MW 12-16	6487.58	140-190	6386.46	6385.65	6384.95	6384.35	6385.83	6,378.58	6378.81	6378.89	6378.88	6378.90	6379.11	6379.87	6381.21	6382.14	6382.94	6380.83	6379.80
MW 12-17	6472.97	155-195	6433.62	6433.15	6432.80	6432.47	6433.33	6,435.20	6435.09	6434.67	6434.39	6434.30	6434.23	6434.21	6433.96	6433.87	6433.63	6433.16	6432.54
MW 12-18	6472.65	80-115	6432.35	6431.77	6431.38	6431.00	6431.93	6,435.33	6434.47	6434.08	6433.78	6433.67	6433.65	6433.48	6433.33	6433.22	6432.97	6432.42	6431.77
MW 15-01	6504.13	182-222	nm	nm	nm	nm	nm	6,444.86	6444.10	6443.93	6443.83	6443.77	6443.72	6443.67	6443.68	6443.61	6443.50	6443.10	6442.78
MW 15-02	6483.34	147-197	nm	nm	nm	nm	nm	6,414.28	6406.91	6407.83	6408.02	6408.02	6408.10	6408.11	6409.44	6411.19	6410.04	6408.96	6408.30
MW 15-03	6487.41	345-385	nm	nm	nm	nm	nm	6,377.78	6379.11	6379.35	6379.23	6379.31	6379.57	6380.81	6381.63	6384.47	6384.28	6378.14	6377.10
MW 15-04	6435.98	170-220	nm	nm	nm	nm	nm	6,373.23	6372.42	6372.07	6371.88	6371.85	6371.91	6372.04	6372.17	6372.03	6372.33	6372.16	6371.79
MW 15-05	6468.72	240-290	nm	nm	nm	nm	nm	6,433.80	6434.28	6433.78	6433.51	6433.48	6433.45	6433.36	6433.32	6433.16	6433.10	6432.68	6432.49
MW 15-06	6468.97	350-400	nm	nm	nm	nm	nm	nm	6428.55	6428.03	6427.76	6427.74	6427.71	6427.72	6427.65	6427.54	6427.38	6427.11	6426.72
MW 15-07	6464.65	162.5-202.5	nm	nm	nm	nm	nm	nm	6390.47	6390.27	6390.04	6390.04	6390.17	6391.00	6393.17	6394.75	6394.78	6390.47	6389.48
MW 15-08	6464.57	81.5-101.5	nm	nm	nm	nm	nm	nm	6404.53	6403.61	6403.24	6403.13	6403.03	6402.97	6402.56	6402.54	6402.61	6401.62	6400.95
MW 15-09	6455.25	92-142	nm	nm	nm	nm	nm	nm	6411.68	6411.31	6410.97	6410.89	6410.78	6410.72	6410.35	6410.30	6410.08	nm	nm
MW 15-10	6369.00	84-99	nm	nm	nm	nm	nm	nm	6331.58	6331.80	6332.12	6332.29	6332.55	6332.58	6333.08	6333.06	nm	nm	nm
MW 15-11	6536.30	161-201	nm	nm	nm	nm	nm	nm	6376.82	6376.67	6376.64	6376.64	6376.64	6376.61	6376.64	6376.64	nm	nm	nm
MW 15-12	6436.18	68.5-98.5	nm	nm	nm	nm	nm	nm	6378.66	6378.48	6378.07	6377.97	6377.90	6377.82	6377.75	6377.74	nm	nm	nm
MW 15-13	6420.83	81-101	nm	nm	nm	nm	nm	nm	6369.29	6369.28	6369.38	6369.49	6369.58	6369.65	6365.92	6366.34	nm	nm	nm
MW 16-01	6501.53	485-517	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
MW 16-02S	6499.33	489-549	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
MW 16-02D	6499.41	244-264	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
516409	6717.30	Open Hole	nm	nm	nm	nm	nm	nm	6598.80	6598.42	6598.24	6598.13	6598.11	6598.02	6597.94	6597.82	nm	nm	nm
516410	6716.83	Open Hole	nm	nm	nm	nm	nm	nm	6591.53	6588.29	6588.02	6587.95	6587.93	6587.83	6587.79	6587.63	nm	nm	nm
514409	6700.14	Open Hole	nm	nm	nm	nm	nm	nm	6578.22	6566.19	6565.99	6565.81	6565.69	6565.61	6565.38	6565.30	nm	nm	nm

NM - Not Measured (well not completed yet)
All measurements in feet
All elevations ACM Datum (USGS=ACM-57.15 ft)

TABLE B-2. WEST RIDGE MONITORING WELL GROUNDWATER ELEVATIONS

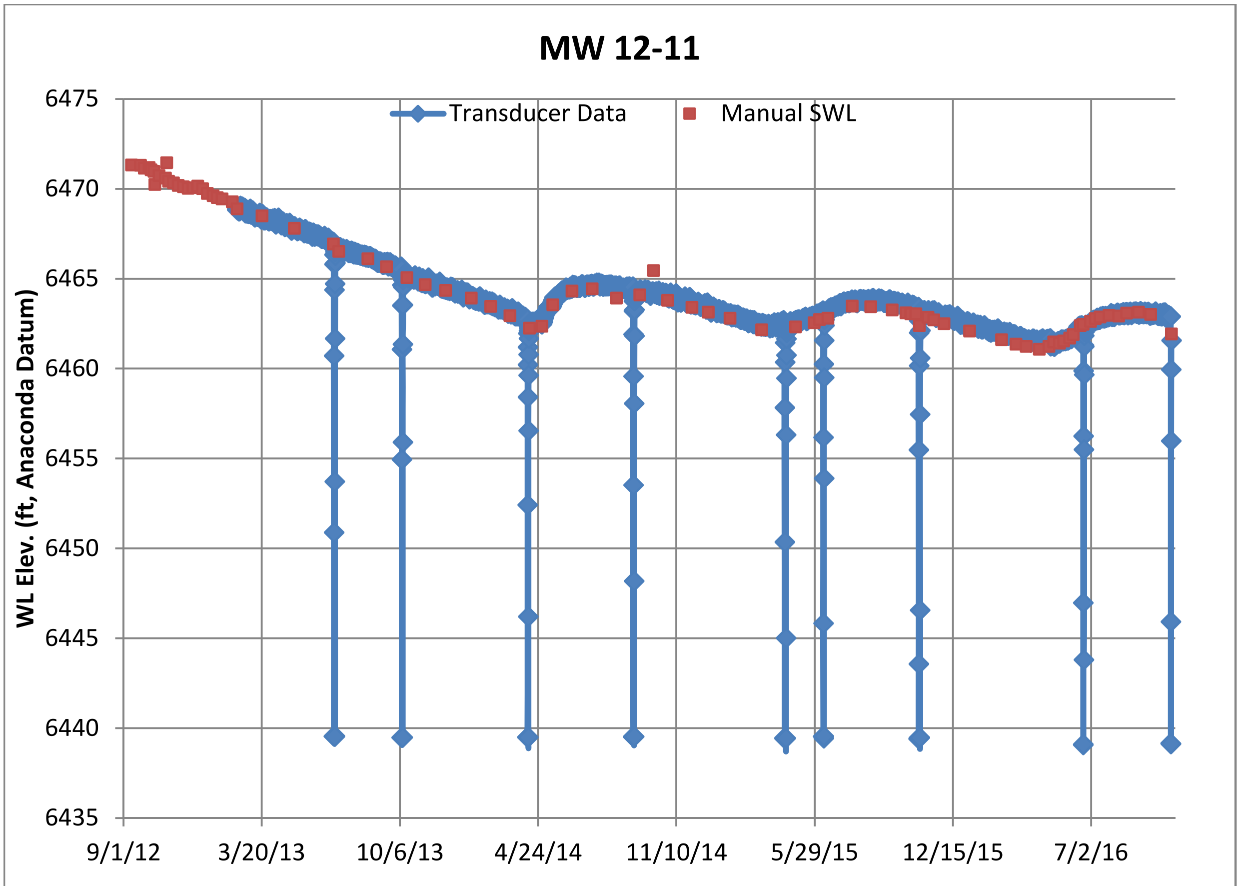
Well	Measuring Point Elev.	Screened Interval feet bgs	Groundwater Elevation																
			3/15/16	3/30/16	4/18/16	5/2/16	5/9/16	5/10/16	5/17/16	5/23/16	6/1/16	6/6/16	6/16/16	6/21/16	7/1/16	7/8/16	7/15/16	7/28/16	8/11/16
MW 12-11	6521.41	145-195	6461.36	6461.23	6461.06	6461.22	6461.47	nm	6461.40	6461.53	6461.70	6461.89	6462.38	6462.45	6462.61	6462.77	6462.87	6462.96	6462.92
MW 12-12	6475.87	160-195	6425.39	6425.59	6426.25	6427.37	6427.90	nm	6427.90	6428.12	6428.77	6429.34	6429.98	6430.46	6429.90	6430.20	6430.10	6429.89	6429.79
MW 12-13	6490.28	145-195	6460.57	6461.39	6466.80	6471.80	6473.67	nm	6474.28	6475.08	6477.00	6477.73	6478.08	6477.94	6477.06	6476.60	6475.90	6474.78	6473.65
MW 12-14	6476.47	100-150	6430.92	6431.15	6434.23	6436.47	6436.96	nm	6436.96	6437.31	6438.90	6439.77	6440.73	6440.75	6440.64	6440.53	6440.28	6439.79	6439.24
MW 12-15	6518.91	150-200	6483.21	6483.13	6483.23	6483.32	6483.39	nm	6483.37	6483.40	6483.46	6483.57	6483.90	6483.96	6483.86	6484.01	6484.12	6484.20	6484.32
MW 12-16	6487.58	140-190	6379.42	6379.24	6379.00	6378.99	6379.49	nm	6379.80	6380.25	6380.64	6380.87	6381.46	6381.66	6382.06	6382.43	6382.74	6383.21	6383.56
MW 12-17	6472.97	155-195	6432.31	6432.29	6432.86	6433.55	6433.88	nm	6434.05	6434.25	6434.59	6434.86	6435.34	6435.39	6435.71	6435.89	6435.97	6436.08	6436.09
MW 12-18	6472.65	80-115	6431.68	6431.82	6433.55	6434.07	6434.38	nm	6434.51	6434.77	6435.46	6435.73	6436.31	6436.45	6436.69	6436.77	6436.79	6436.73	6436.50
MW 15-01	6504.13	182-222	6439.95	6438.21	6440.40	6434.65	6429.45	6429.73	6431.01	6431.90	6432.11	6432.90	6430.18	6430.85	6432.23	6432.83	6433.34	6434.01	6434.52
MW 15-02	6483.34	147-197	6408.87	6409.02	6409.83	6410.80	6411.02	nm	6411.05	6411.39	6412.36	6412.78	6413.48	6413.66	6413.93	6414.07	6414.12	6414.22	6414.18
MW 15-03	6487.41	345-385	6376.94	6376.84	6376.74	6376.89	6377.37	nm	6377.44	6377.83	6378.09	6378.39	6378.94	6378.76	6379.19	6379.64	6379.79	6380.29	6380.59
MW 15-04	6435.98	170-220	6371.70	6371.65	6371.71	6374.67	6382.94	nm	6384.00	6384.41	6384.68	6385.50	6388.03	6387.68	6387.14	6386.74	6386.18	6385.23	6384.48
MW 15-05	6468.72	240-290	6432.45	6432.57	6433.31	6433.88	6434.18	nm	6434.19	6434.35	6434.85	6435.05	6435.46	6435.47	6435.67	6435.68	6435.65	6434.59	6435.50
MW 15-06	6468.97	350-400	6426.76	6426.81	6426.70	6427.79	6428.34	nm	6428.30	6428.56	6428.78	6429.09	6429.58	6429.63	6429.74	6429.94	6429.89	6429.82	6429.74
MW 15-07	6464.65	162.5-202.5	6388.98	6389.01	6389.56	6390.43	6390.74	nm	6390.68	6390.85	6391.37	6391.86	6392.54	6392.71	6392.60	6392.87	6392.88	6392.93	6392.87
MW 15-08	6464.57	81.5-101.5	6400.42	6400.61	6401.69	6402.66	6402.83	nm	6402.89	6402.93	6403.70	6404.33	6405.16	6405.49	6405.38	6405.56	6405.51	6405.28	6404.82
MW 15-09	6455.25	92-142	nm	nm	6408.81	6409.49	6409.85	nm	6410.07	6410.23	6410.56	6410.93	6411.62	6411.78	6411.78	6412.00	6412.11	6412.17	6412.13
MW 15-10	6369.00	84-99	nm	nm	6337.14	6337.49	nm	nm	6337.78	6338.15	nm	nm	nm	6338.45	6338.45	6338.40	6338.35	6338.34	6338.20
MW 15-11	6536.30	161-201	nm	nm	6376.62	6376.68	nm	nm	6376.66	6376.64	nm	nm	nm	6376.90	6376.83	6376.78	6376.77	6376.68	6376.60
MW 15-12	6436.18	68.5-98.5	nm	nm	6378.05	6377.78	nm	nm	6377.30	6377.44	6377.92	nm	nm	6377.59	6377.49	6377.47	6377.51	6377.66	6377.83
MW 15-13	6420.83	81-101	nm	nm	6368.89	6368.31	nm	nm	6368.56	6368.57	6368.57	nm	nm	6368.86	6367.61	6367.45	6367.24	6366.88	6366.46
MW 16-01	6501.53	485-517	nm	nm	6342.83	6337.17	6394.97	6400.12	6415.35	6411.35	6401.90	6421.46	6398.50	6391.37	6387.87	6382.58	6378.74	6339.83	6362.77
MW 16-02S	6499.33	489-549	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	6427.88	6430.33	6431.35	6432.16	6431.93	6433.46
MW 16-02D	6499.41	244-264	nm	nm	nm	nm	nm	nm	6425.91	6429.41	6427.91	6431.41	nm	nm	6387.14	6381.99	6378.16	6338.40	6363.23
516409	6717.30	Open Hole	nm	nm	6596.11	6596.25	nm	nm	6596.46	6596.57	nm	nm	nm	6597.38	6597.65	6597.82	6597.91	6598.04	6598.12
516410	6716.83	Open Hole	nm	nm	6587.08	6587.04	nm	nm	6587.06	6587.07	nm	nm	nm	6587.16	6587.34	6587.51	6587.61	6587.76	6587.86
514409	6700.14	Open Hole	nm	nm	6568.42	6577.68	nm	nm	6574.14	6575.35	nm	nm	nm	6586.90	6587.91	6588.54	6588.77	6588.49	6588.30

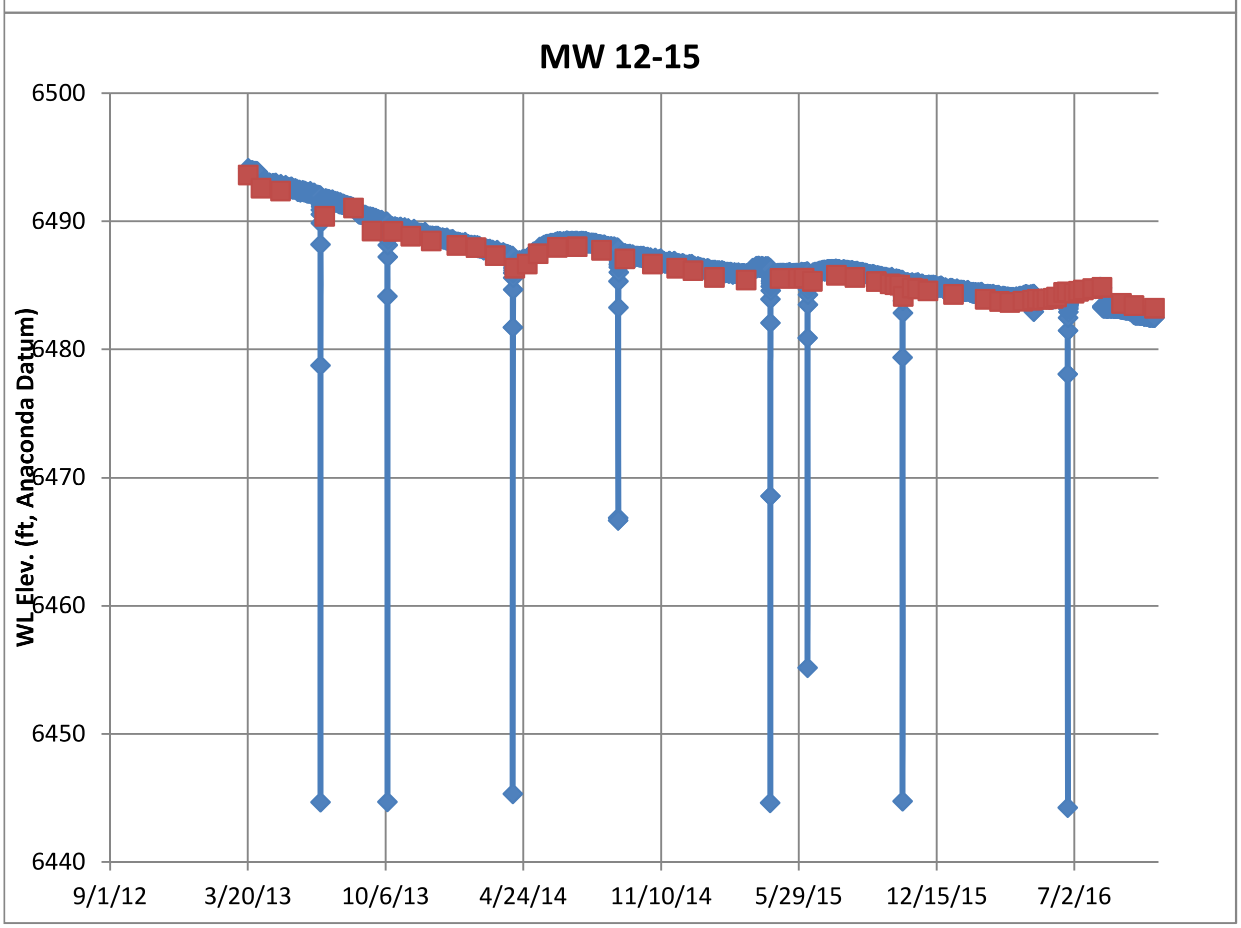
NM - Not Measured (well not completed yet)
All measurements in feet
All elevations ACM Datum (USGS=ACM-57.15 ft)

TABLE B-2. WEST RIDGE MONITORING WELL GROUNDWATER ELEVATIONS

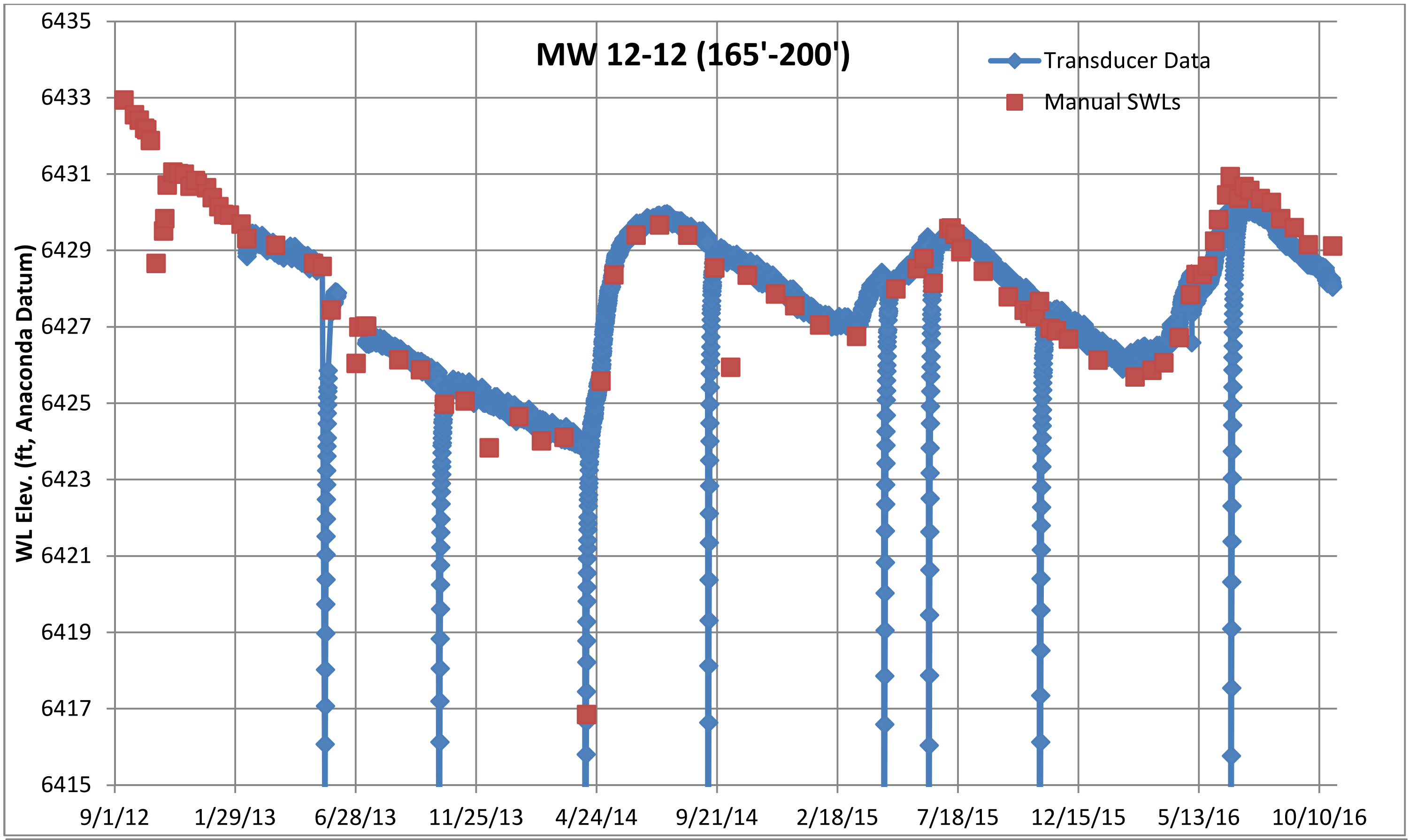
Well	Measuring Point Elev.	Screened Interval feet bgs	Groundwater Elevation										
			8/23/16	9/8/16	9/26/16	10/26/16	11/22/16	3/10/17	4/12/17	4/28/17	5/15/17	5/29/17	6/16/17
MW 12-11	6521.41	145-195	6463.08	6463.13	6463.00	6461.92	6462.51	6461.24	6461.14	6461.44	6462.16	6463.68	6466.51
MW 12-12	6475.87	160-195	6429.36	6429.13	6428.68	6428.65	6427.77	6426.28	6429.64	6430.61	6431.74	6435.79	6438.25
MW 12-13	6490.28	145-195	6472.66	6471.28	6469.77	6467.74	6467.04	6463.13	6471.18	6473.88	6475.95	6480.33	6481.63
MW 12-14	6476.47	100-150	6438.72	6438.07	6437.28	6436.22	6429.49	6432.80	6440.27	6439.87	6443.21	6451.41	6454.73
MW 12-15	6518.91	150-200	6483.59	6483.50	6483.31	6483.11	6482.81	6481.39	6482.20	6482.19	6482.54	6483.56	6485.79
MW 12-16	6487.58	140-190	6384.07	6384.66	6384.98	6385.35	6385.75	6385.75	6385.69	6385.94	6386.42	6386.70	6387.61
MW 12-17	6472.97	155-195	6436.08	6435.93	6435.58	6434.83	6434.77	6433.35	6434.43	6435.14	6436.07	6438.00	6440.92
MW 12-18	6472.65	80-115	6436.30	6435.94	6435.45	6434.93	6434.48	6432.82	6436.10	6436.68	6437.70	6441.22	6447.20
MW 15-01	6504.13	182-222	6434.65	6434.34	6434.33	6434.78	6434.98	6435.53	6436.71	6437.31	6438.15	6440.64	6443.35
MW 15-02	6483.34	147-197	6414.10	6413.90	6413.56	6412.69	6412.42	6410.38	6413.09	6414.40	6415.78	6421.44	6426.96
MW 15-03	6487.41	345-385	6381.08	6381.61	6381.61	6382.72	6382.13	6382.33	6382.79	6383.13	6383.61	6384.17	6385.29
MW 15-04	6435.98	170-220	6387.00	6386.34	6385.04	6383.93	6383.12	6380.70	6384.43	6385.83	6386.86	6389.66	6391.63
MW 15-05	6468.72	240-290	6435.38	6435.13	6434.77	6434.51	6434.16	6433.09	6434.80	6435.49	6436.35	6439.62	6442.05
MW 15-06	6468.97	350-400	6429.45	6429.26	6428.88	6428.73	6428.44	6427.54	6429.02	6429.64	6430.62	6432.82	6435.10
MW 15-07	6464.65	162.5-202.5	6392.88	6392.85	6392.59	6391.72	6392.32	6391.61	6393.71	6394.38	6395.28	6398.96	6401.80
MW 15-08	6464.57	81.5-101.5	6404.46	6403.93	6403.39	6402.76	6402.57	6400.87	6404.32	6405.24	6406.47	6413.12	6417.64
MW 15-09	6455.25	92-142	6412.05	nm	6411.55	6410.20	6410.40	nm	6409.05	6410.17	6411.65	6414.65	6417.18
MW 15-10	6369.00	84-99	nm	nm	6338.32	6338.96	6339.45	nm	nm	nm	nm	nm	nm
MW 15-11	6536.30	161-201	nm	nm	6376.40	6376.36	6376.39	nm	nm	nm	nm	nm	nm
MW 15-12	6436.18	68.5-98.5	nm	nm	6377.88	6377.92	6377.78	nm	6377.84	6378.21	6377.85	nm	6380.78
MW 15-13	6420.83	81-101	nm	nm	6365.64	6365.67	6365.21	nm	6368.25	6368.85	6369.80	nm	6373.91
MW 16-01	6501.53	485-517	nm	6214.04	6258.98	6330.52	6344.13	6368.67	6372.25	6373.76	6375.45	6376.66	6378.59
MW 16-02S	6499.33	489-549	nm	6432.26	6433.41	6433.95	6434.20	6434.90	6436.08	6436.70	6437.55	6440.45	6443.26
MW 16-02D	6499.41	244-264	nm	6214.44	6259.70	6331.00	6344.78	6369.57	6373.22	6374.84	6376.56	6377.87	6379.89
516409	6717.30	Open Hole	nm	nm	6598.21	6597.88	6597.57	nm	nm	nm	nm	nm	nm
516410	6716.83	Open Hole	nm	nm	6587.75	6587.60	6587.37	nm	nm	nm	nm	nm	nm
514409	6700.14	Open Hole	nm	nm	6587.39	6585.75	6583.11	nm	nm	nm	nm	nm	nm

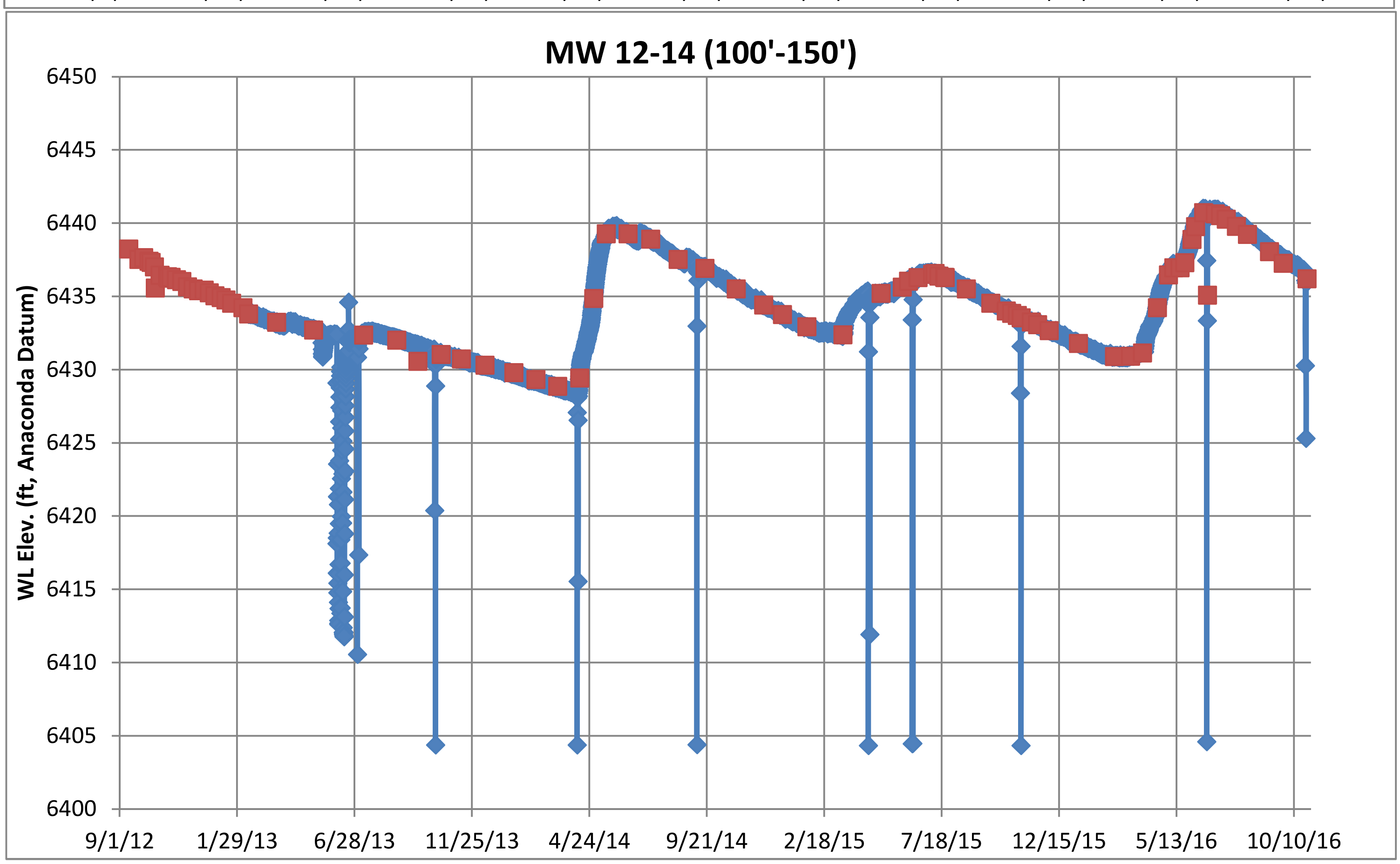
NM - Not Measured (well not completed yet)
All measurements in feet
All elevations ACM Datum (USGS=ACM-57.15 ft)



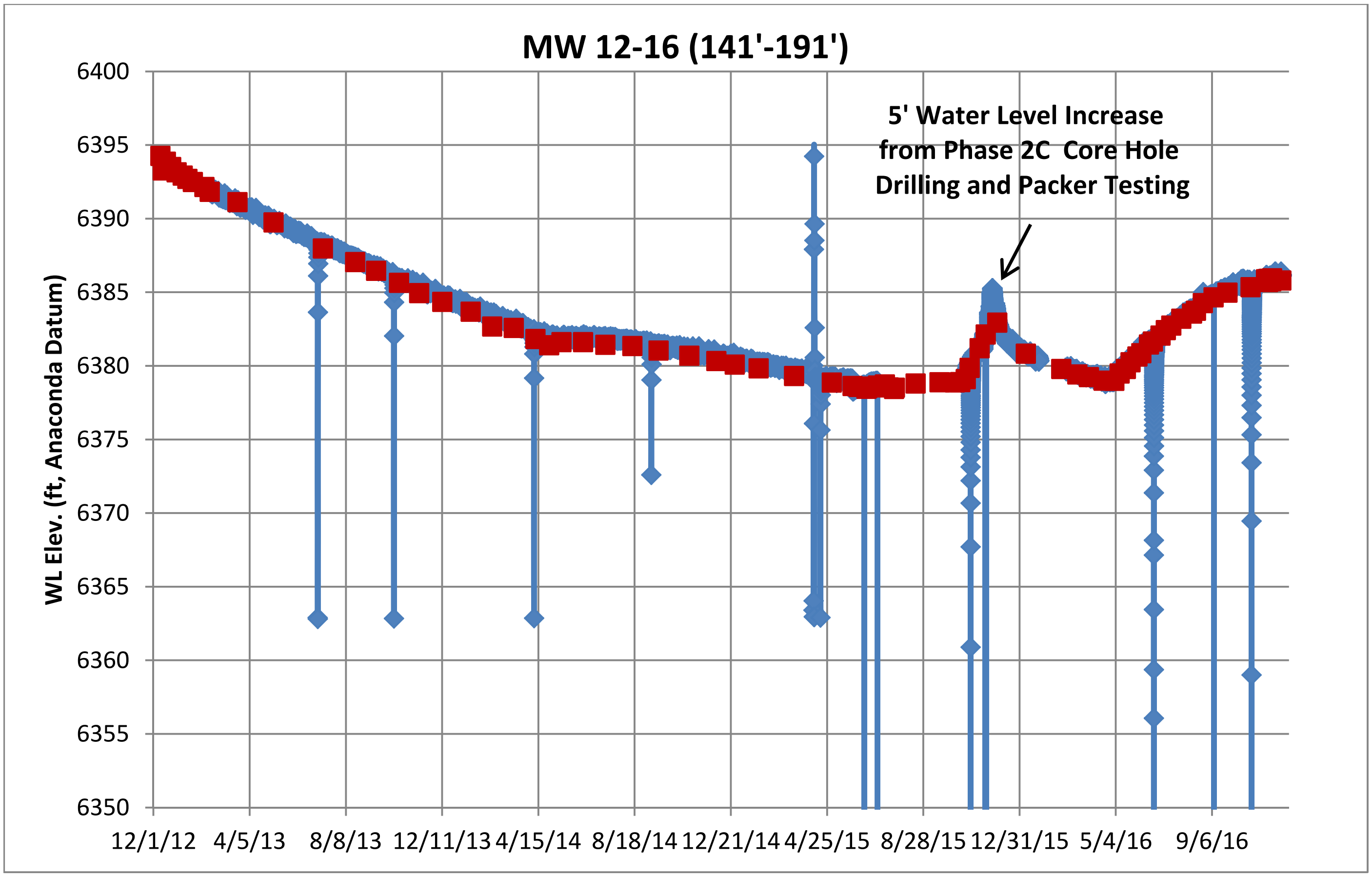


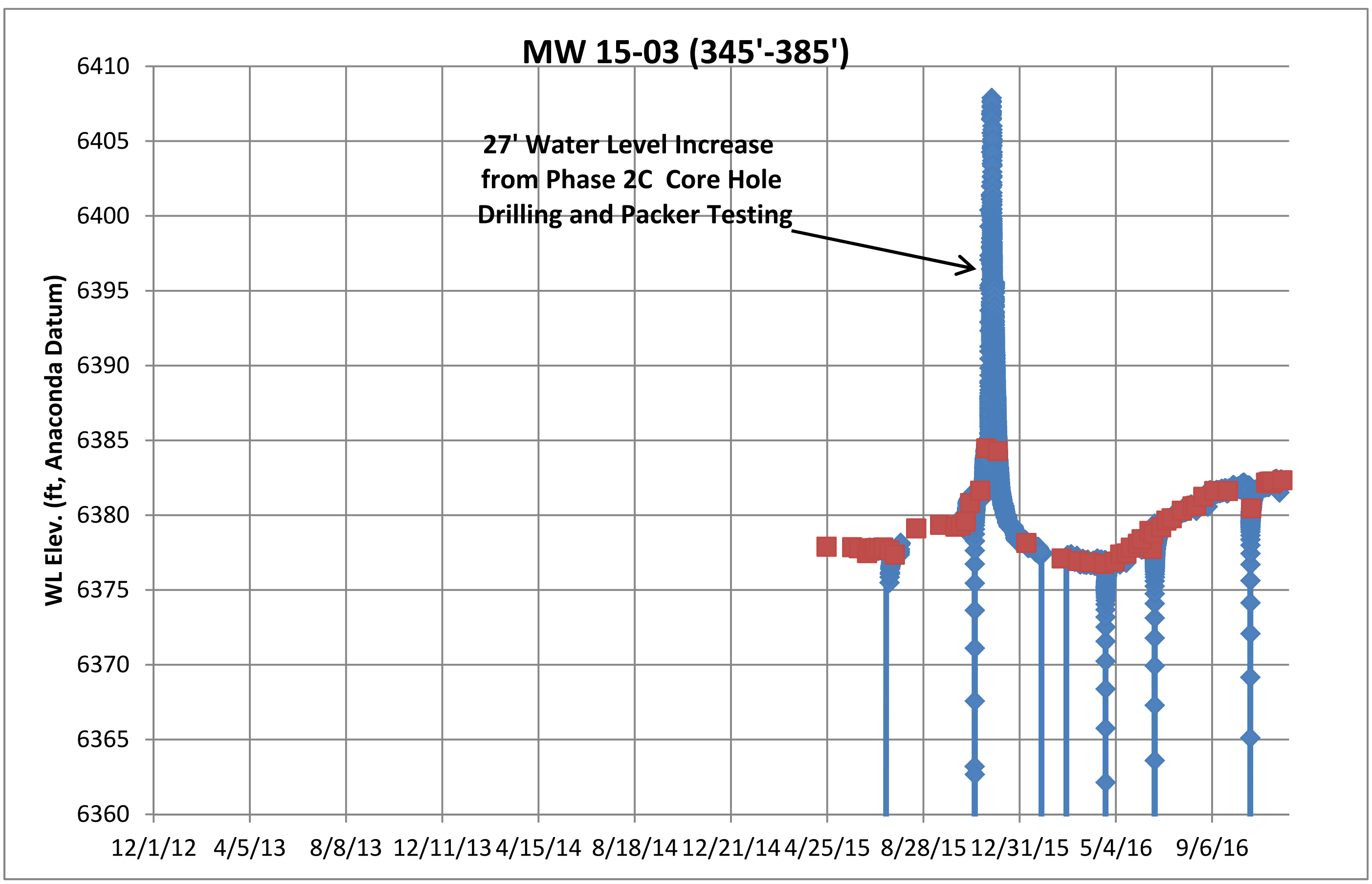
SOUTH WEST RIDGE MONITORING WELLS MW12-15 AND MW12-11 MANUAL AND TRANSDUCER WATER LEVEL DATA



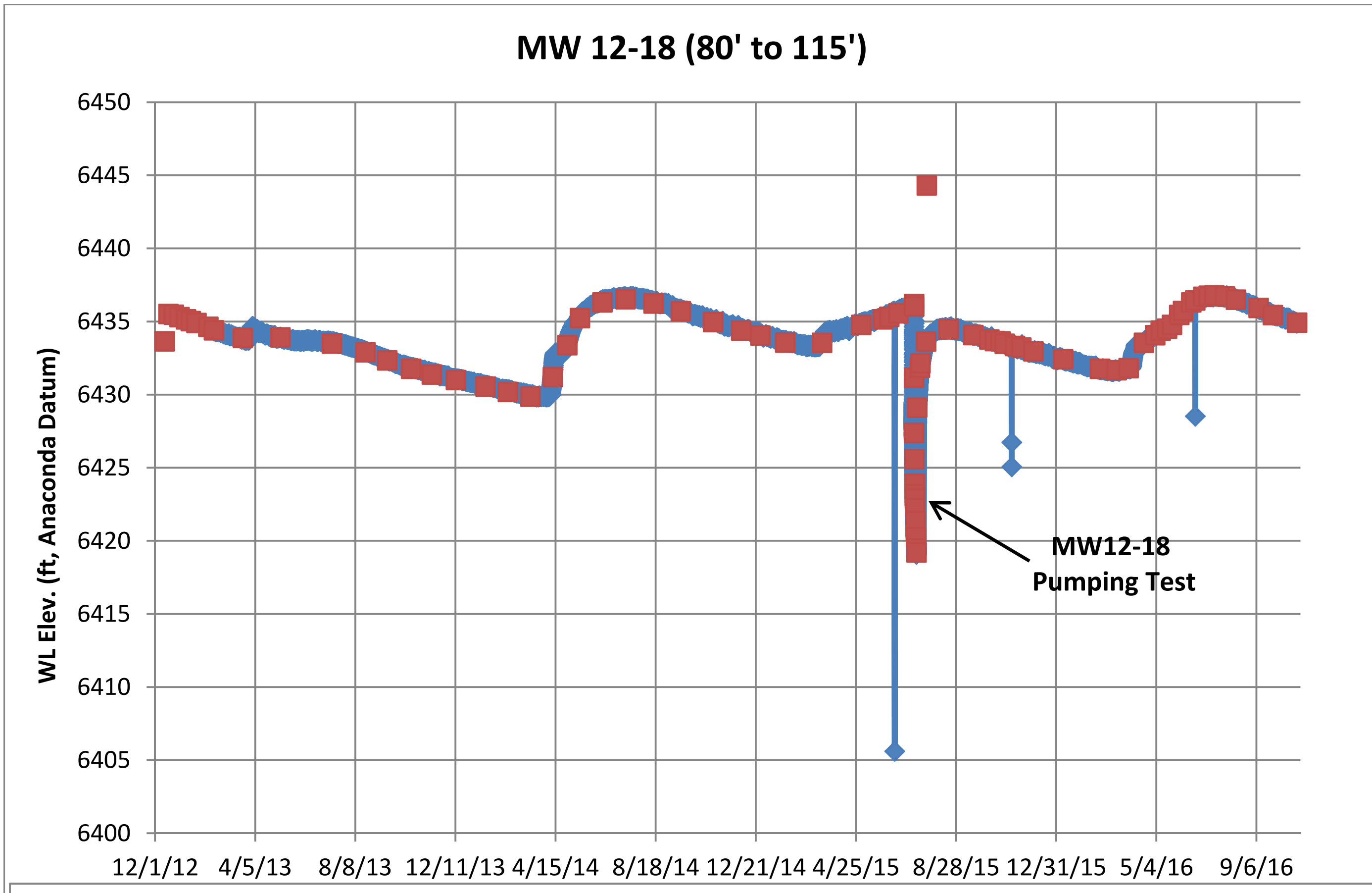


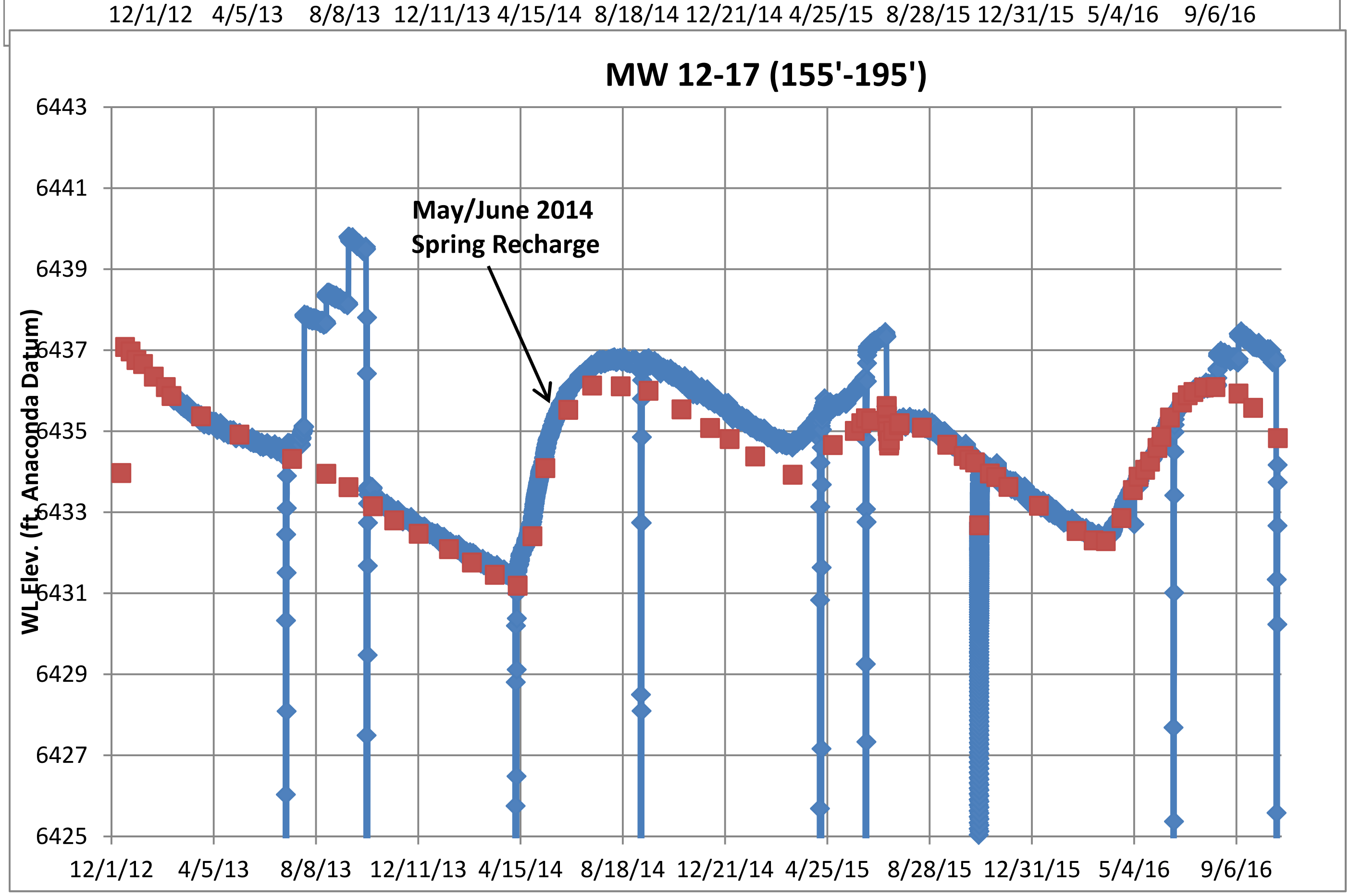
PAIRED MONITORING WELLS MW12-12 AND MW12-14 WATER LEVEL HYDROGRAPHS



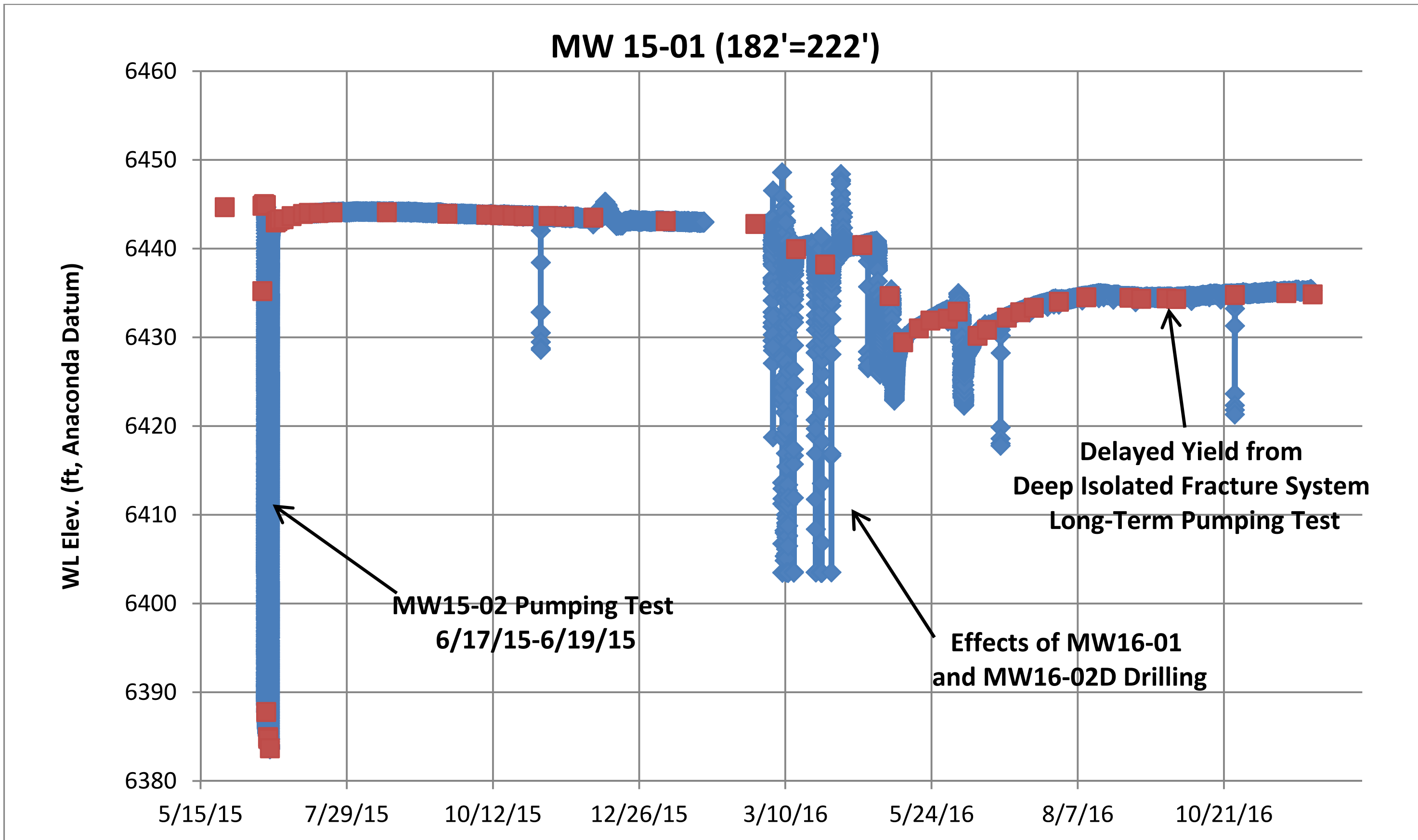


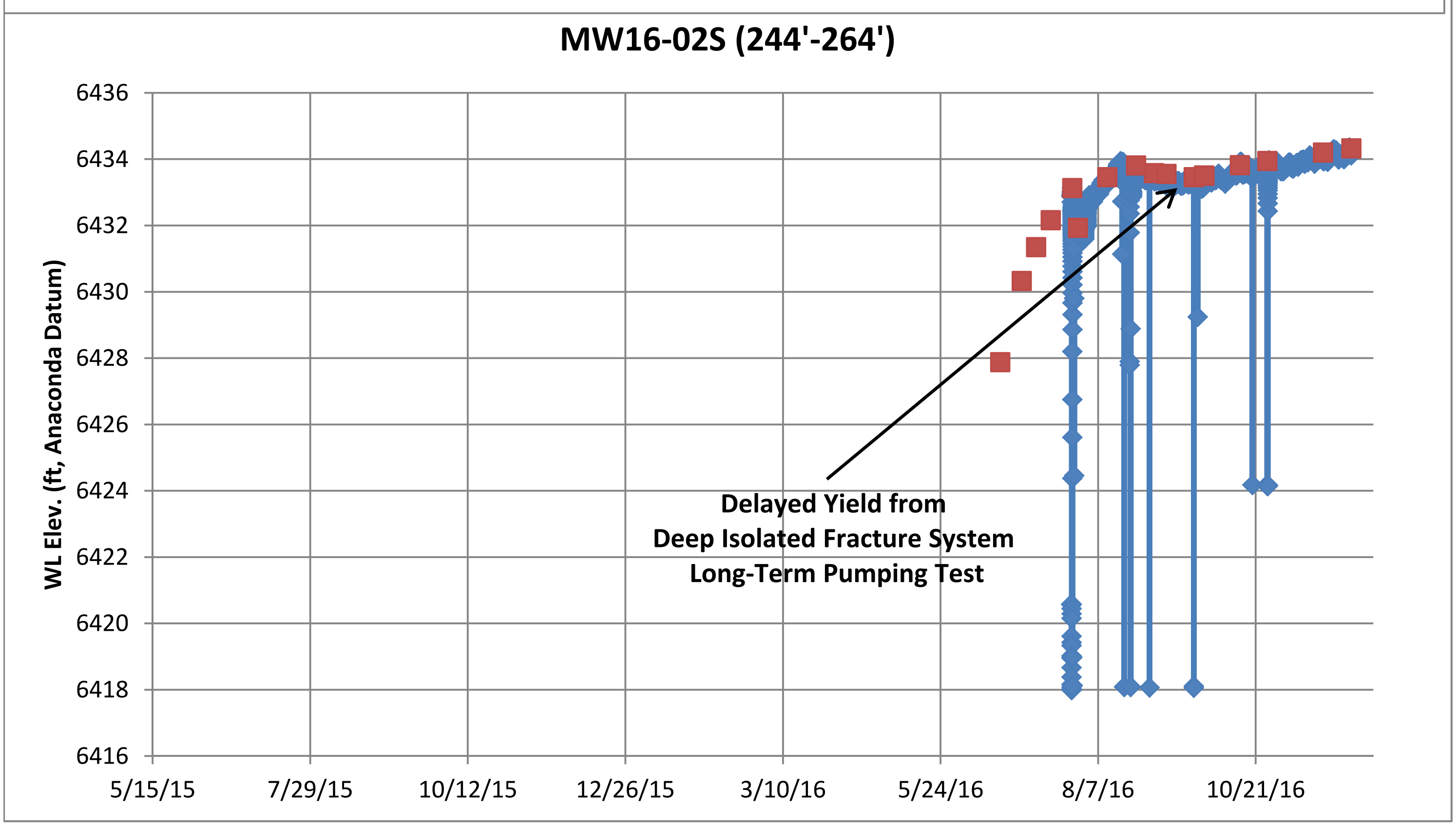
PAIRED MONITORING WELLS MW12-16 AND MW15-03 WATER LEVEL HYDROGRAPHS



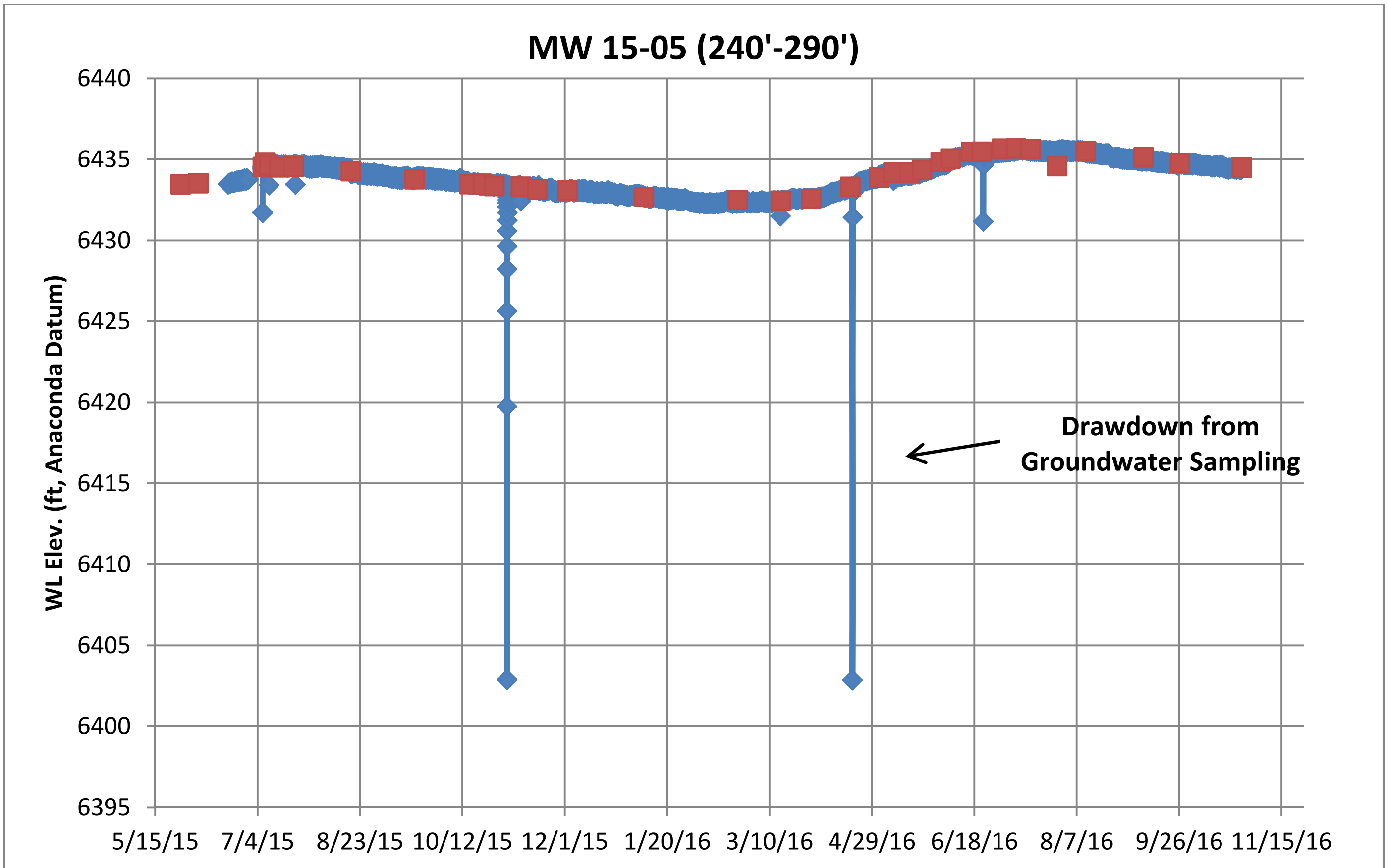


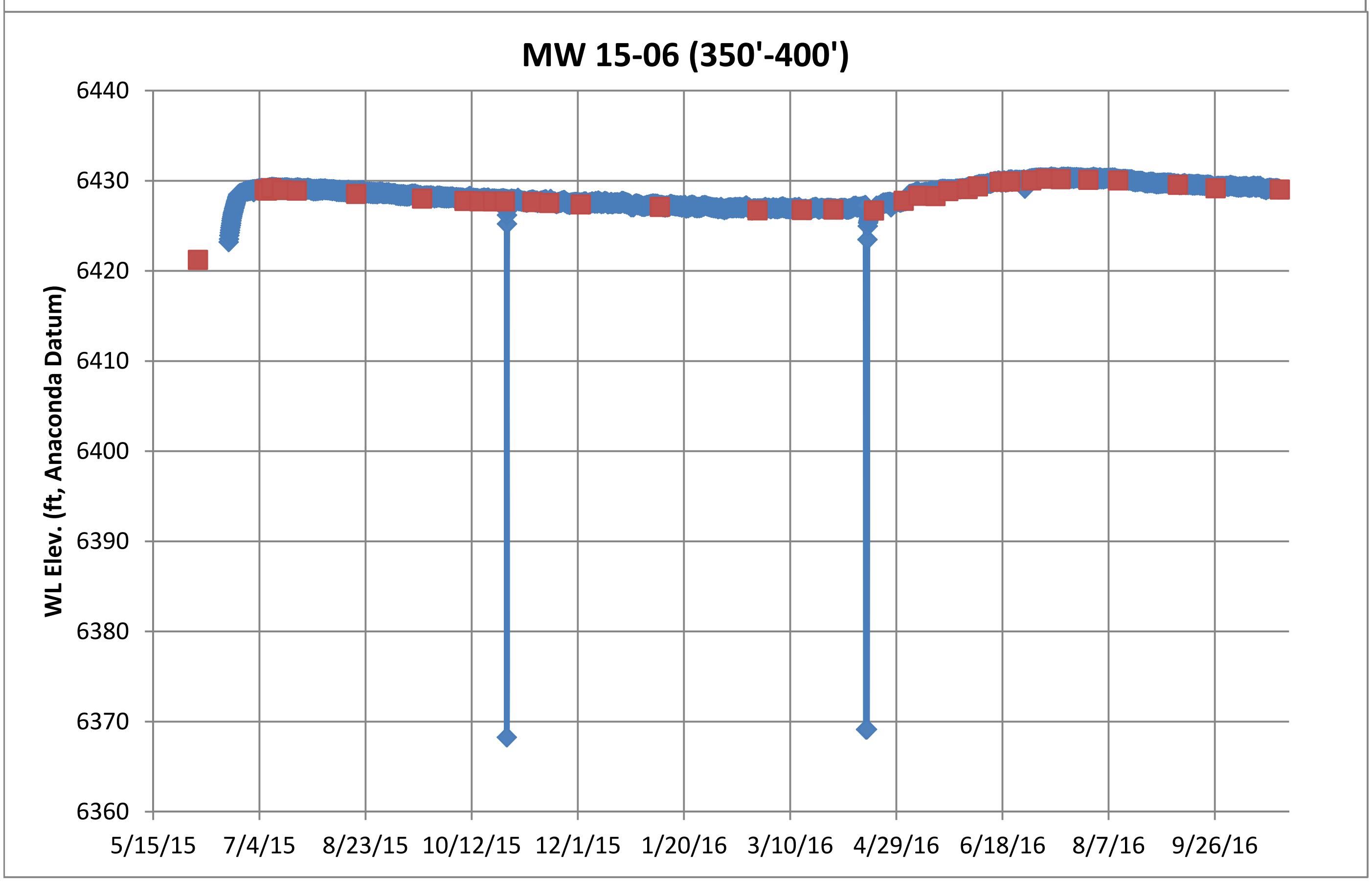
PAIRED WELLS MW12-17 AND MW12-18 WATER LEVEL HYDROGRAPHS



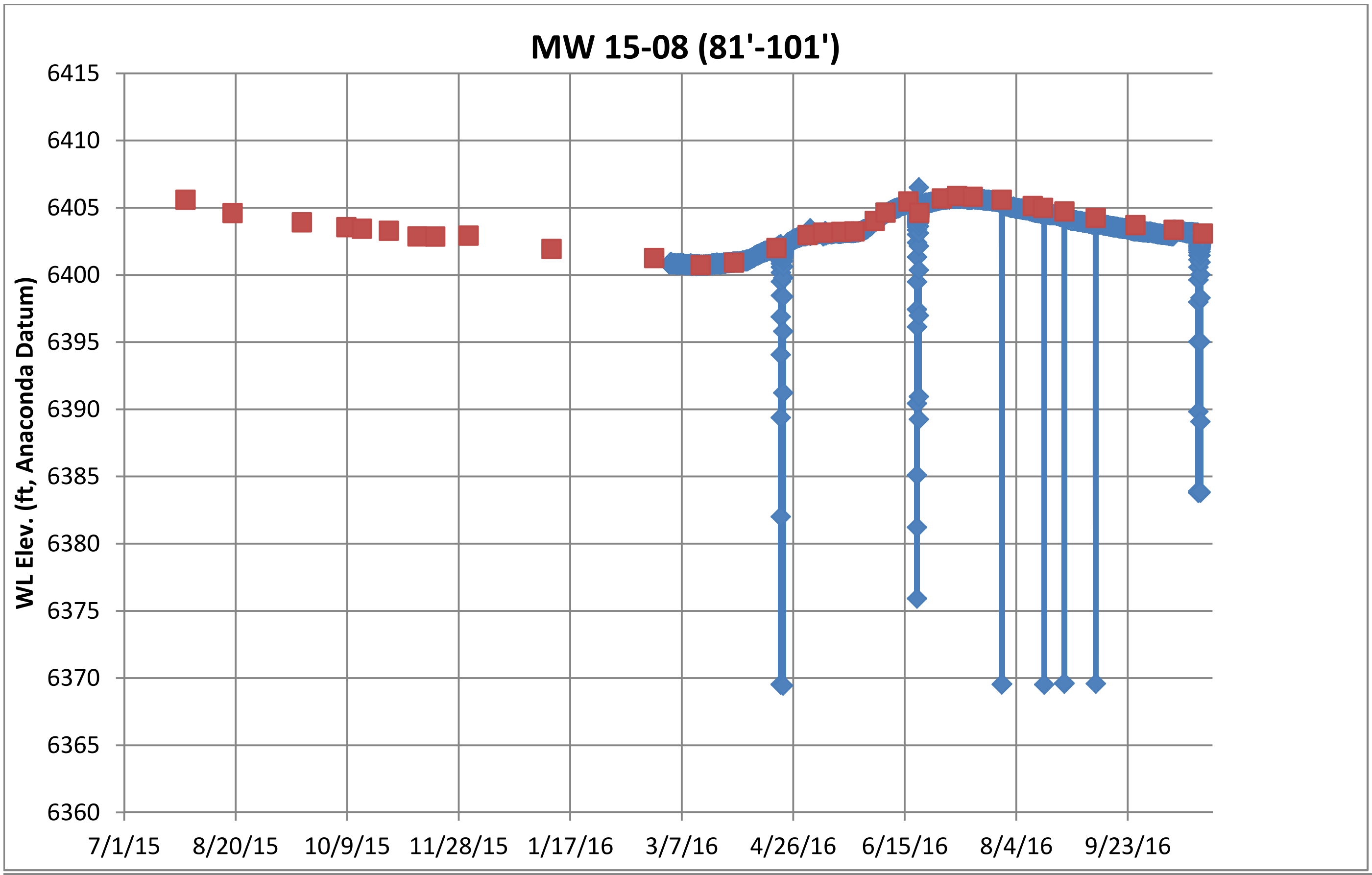


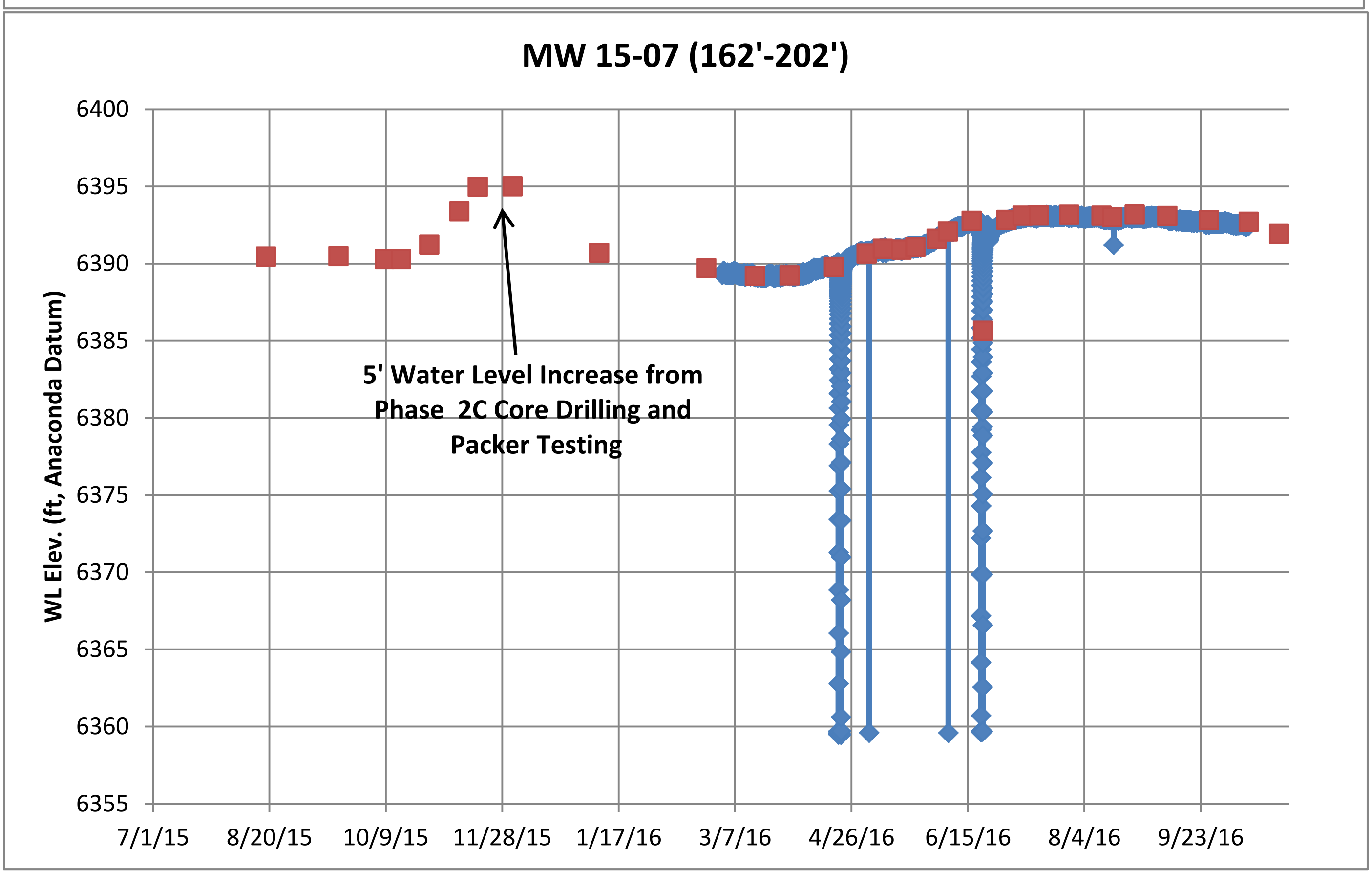
MONITORING WELL MW15-01 AND MW16-02S WATER LEVEL HYDROGRAPHS. WELLS COMPLETED ABOVE DEEP ISOLATED FRACTURE SYSTEM



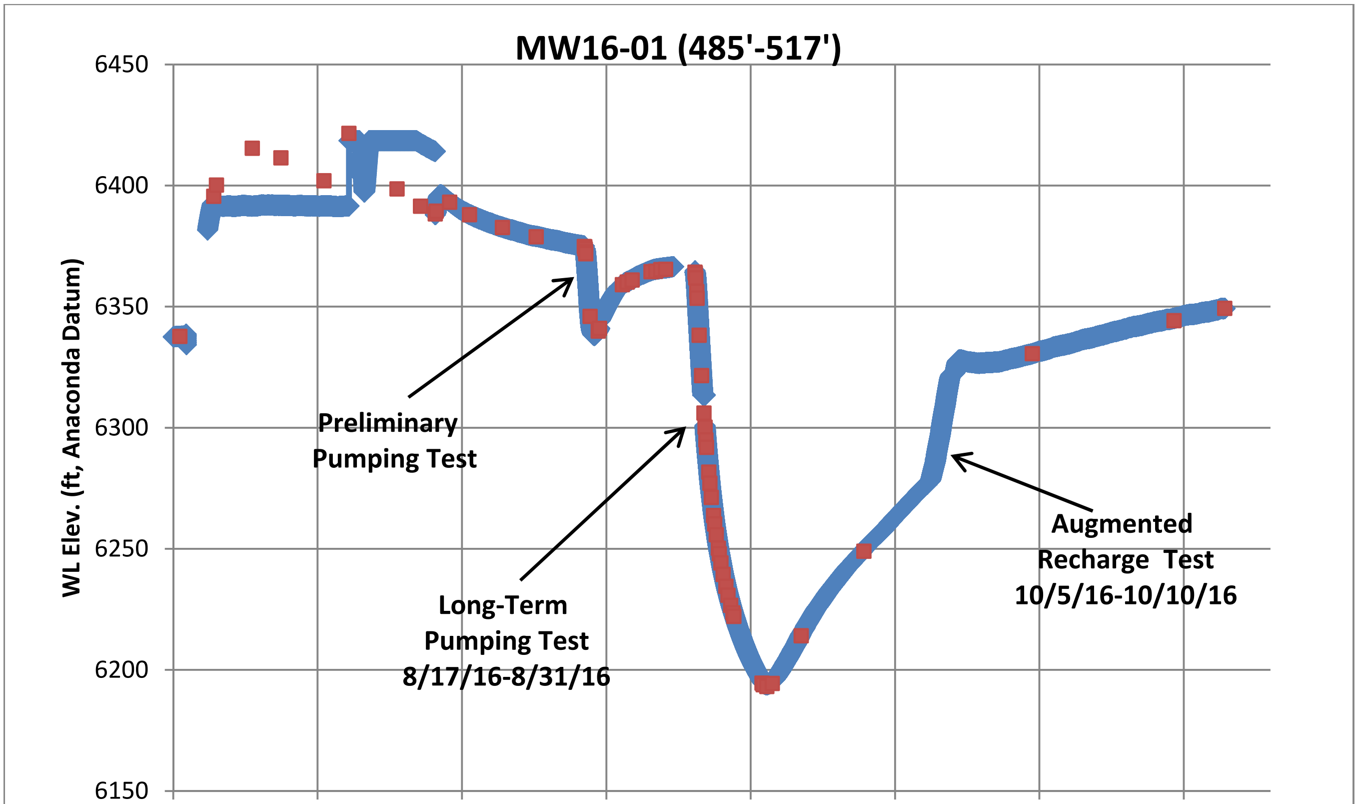


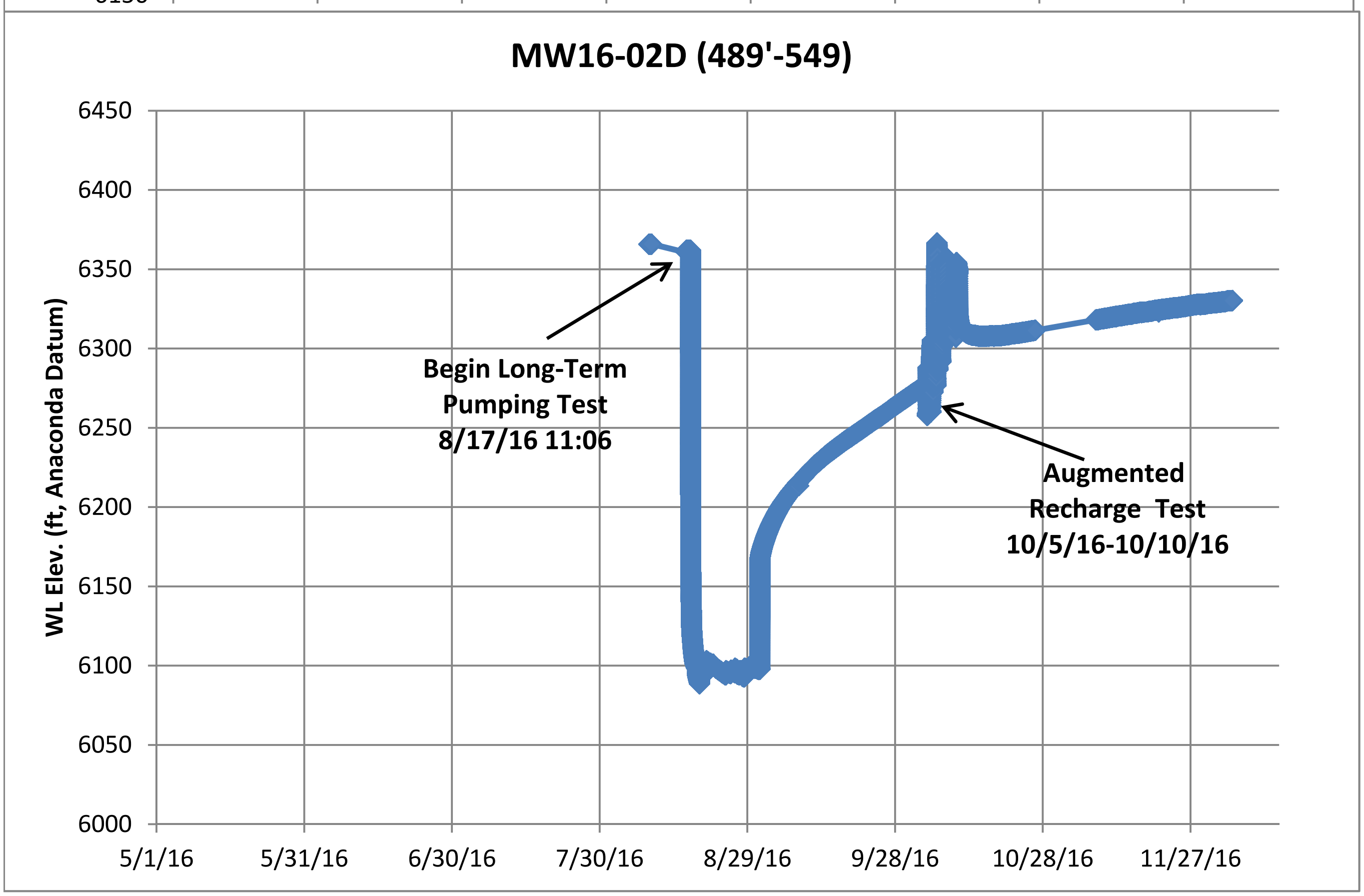
PAIRED MONITORING WELLS MW15-05 AND MW15-06 WATER LEVEL HYDROGRAPHS





PAIRED MONITORING WELLS MW15-07 AND MW15-08 WATER LEVEL HYDROGRAPHS





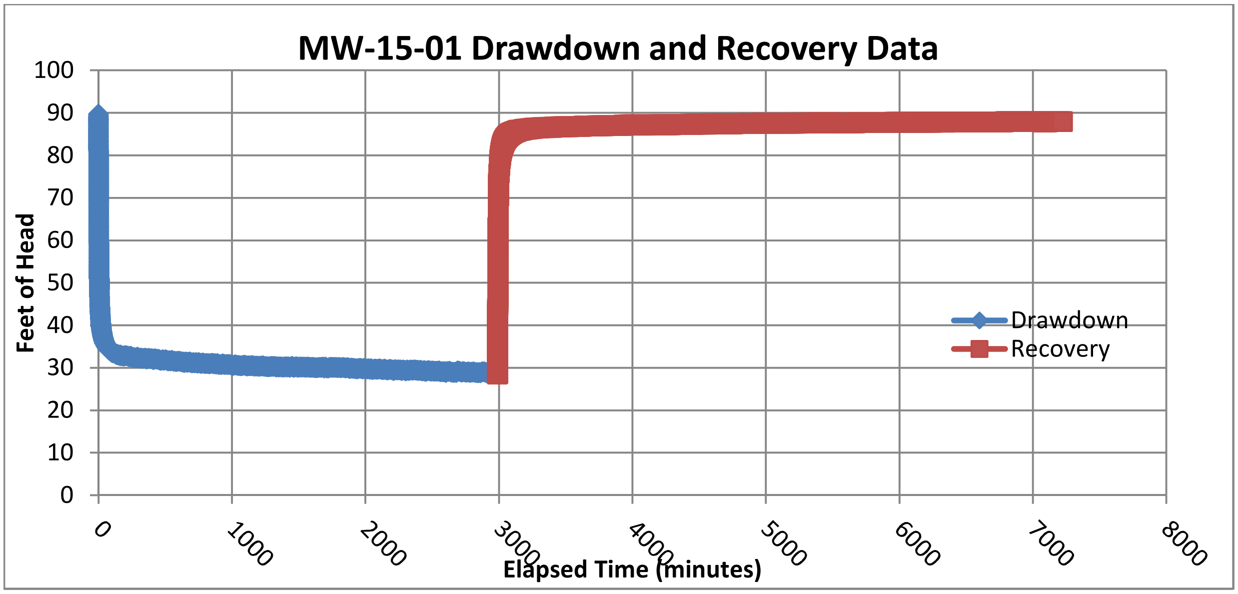
DEEP ISOLATED FRACTURE SYSTEM MONITORING WELLS MW16-01 AND MW16-02D HYDROGRAPHS

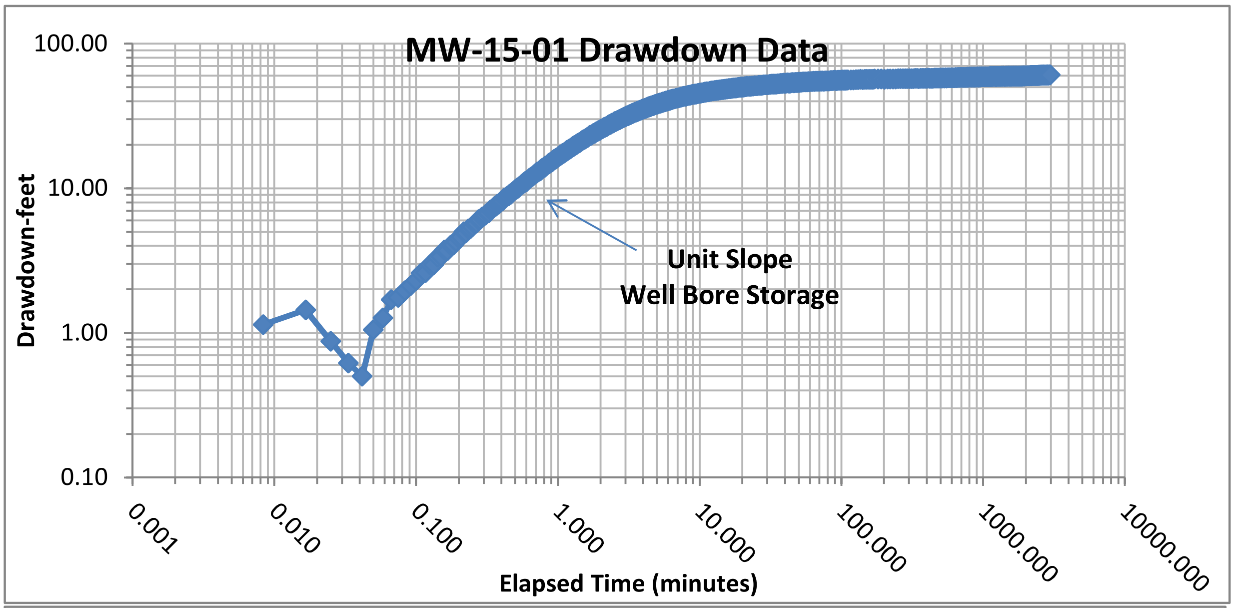
APPENDIX C

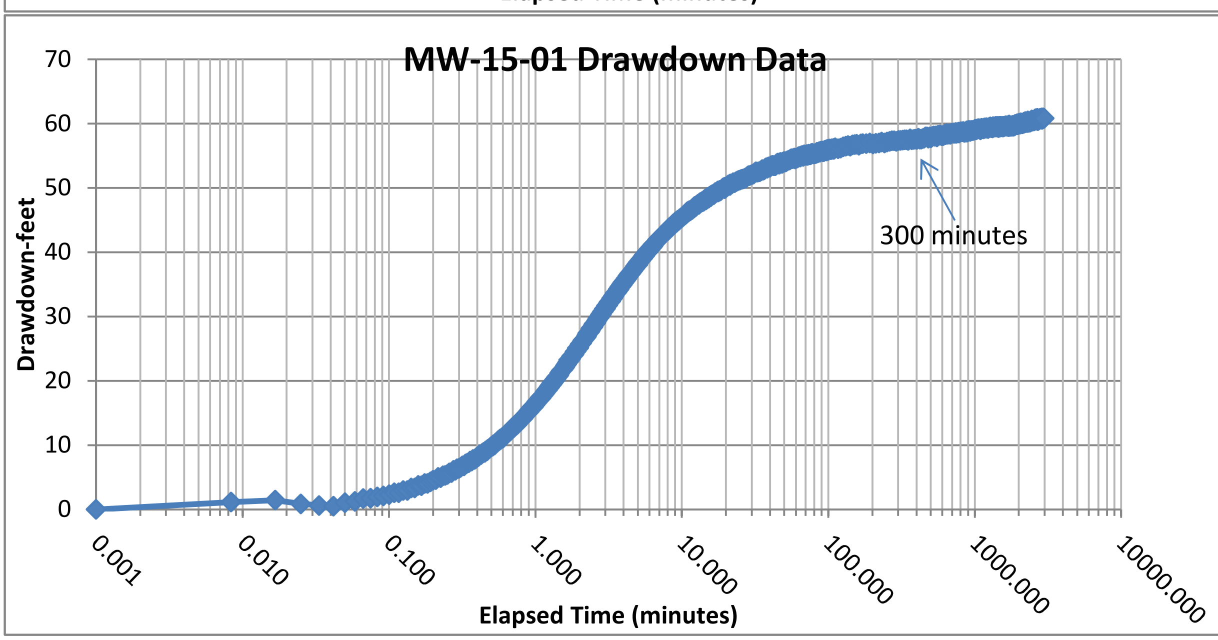
AQUIFER TESTING DATA AND SOLUTIONS

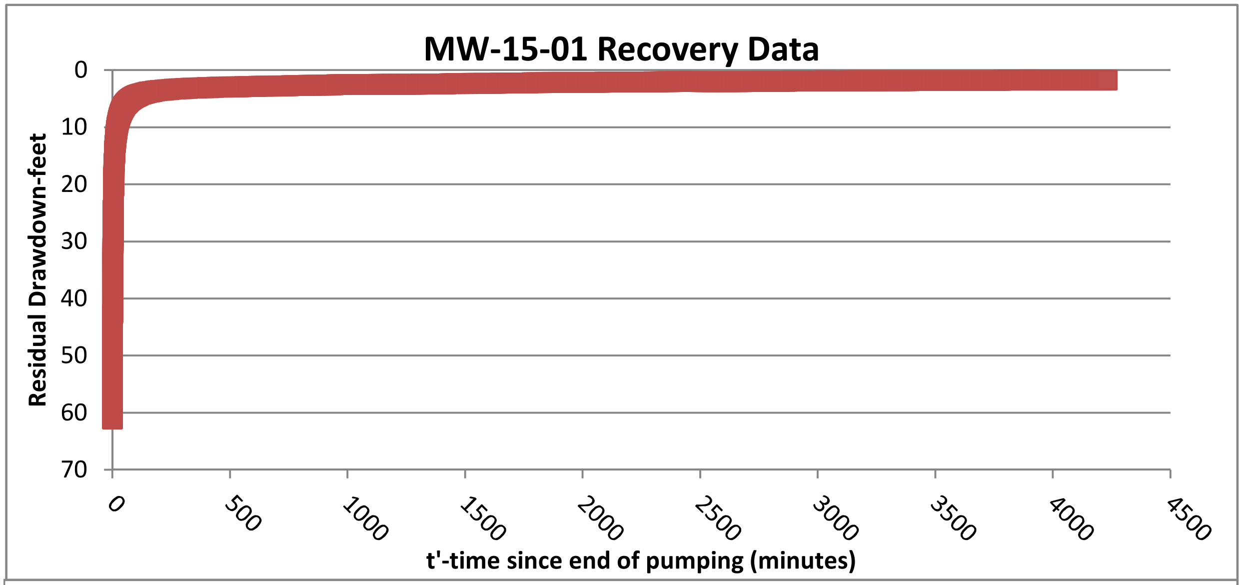
APPENDIX C-1

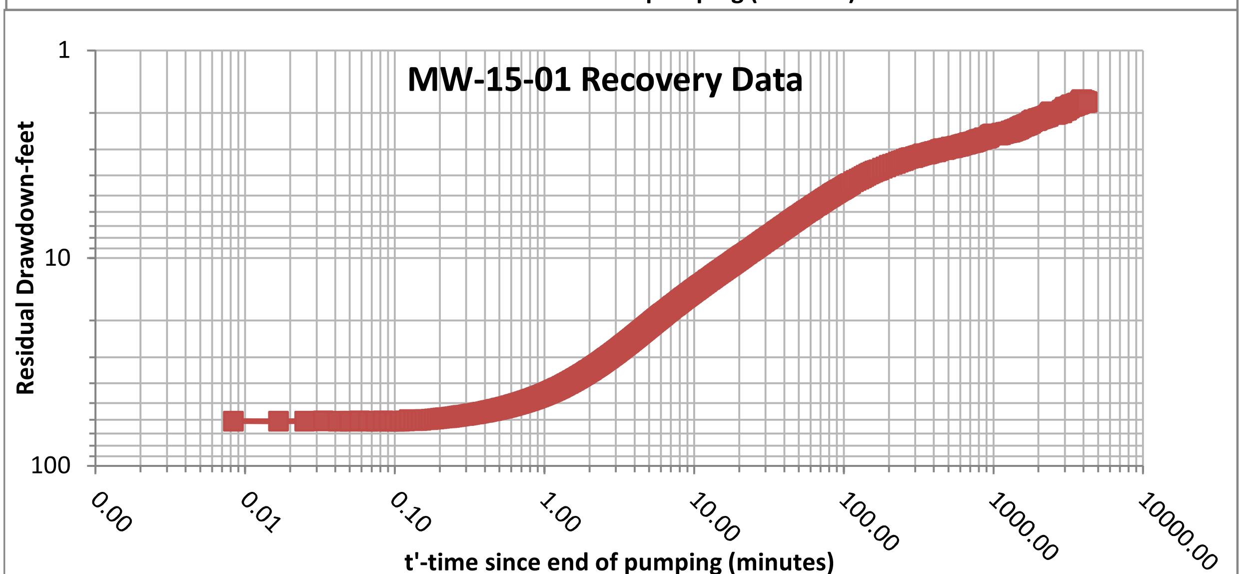
MW15-01, MW15-02 AND MW12-18 CONSTANT DISCHARGE PUMPING TEST DIAGNOSTIC CURVES AND AQTESOLVE CURVE MATHCHING PLOTS

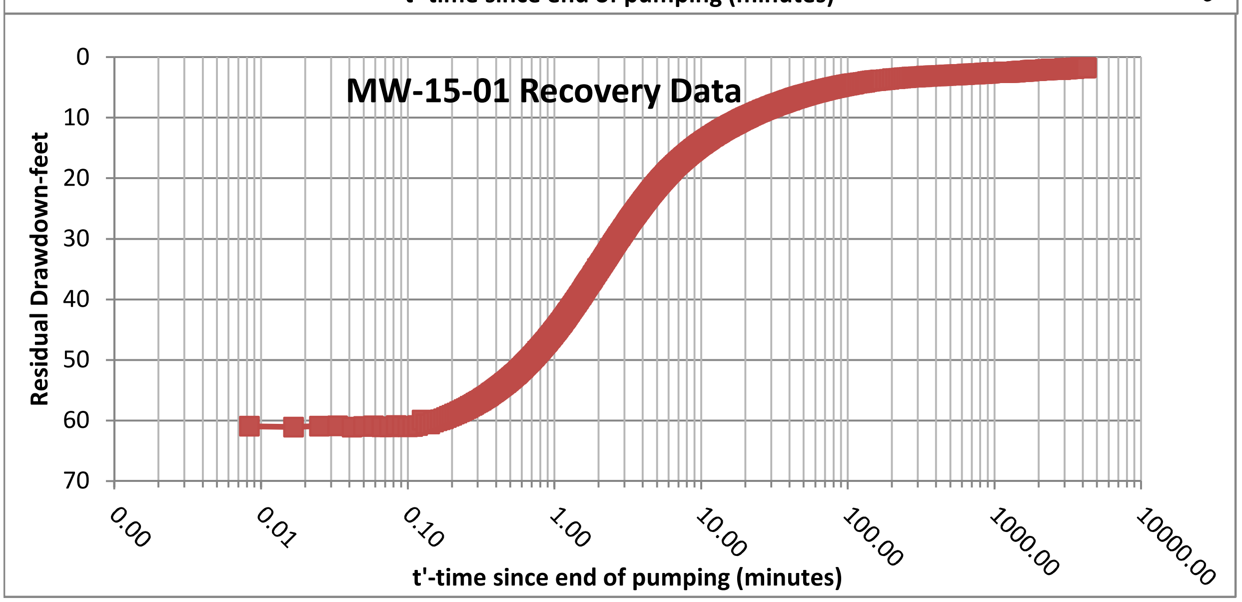

MW-15-01 Drawdown and Recovery Data
Feet of Head
Elapsed Time (minutes)
Drawdown
Recovery
0
10
20
30
40
50
60
70
80
90
100
0
1000
2000
3000
4000
5000
6000
7000
8000

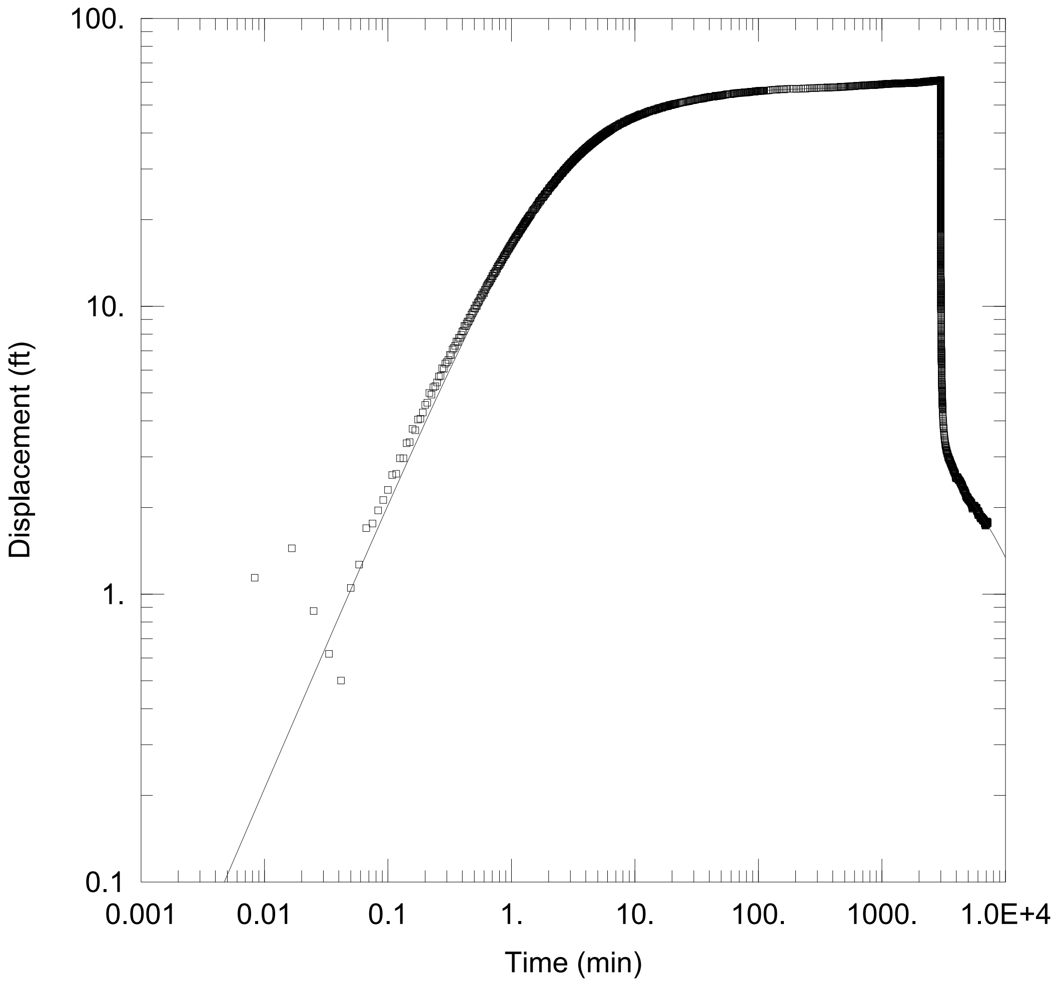

MW-15-01 Drawdown Data
Drawdown-feet
Elapsed Time (minutes)
Unit Slope
Well Bore Storage
0.10
1.00
10.00
100.00
0.001
0.010
0.100
1.000
10.000
100.000
1000.000
10000.000


MW-15-01 Drawdown Data
Drawdown-feet
Elapsed Time (minutes)
300 minutes
0
10
20
30
40
50
60
70
0.001
0.010
0.100
1.000
10.000
100.000
1000.000
10000.000


MW-15-01 Recovery Data
Residual Drawdown-feet
0
10
20
30
40
50
60
70
0
500
1000
1500
2000
2500
3000
3500
4000
4500
t'-time since end of pumping (minutes)


MW-15-01 Recovery Data
Residual Drawdown-feet
1
10
100
0.00
0.01
0.10
1.00
10.00
100.00
1000.00
10000.00
t'-time since end of pumping (minutes)


MW-15-01 Recovery Data
Residual Drawdown-feet
0
10
20
30
40
50
60
70
0.00
0.01
0.10
1.00
10.00
100.00
1000.00
10000.00
t'-time since end of pumping (minutes)



WELL TEST ANALYSIS

Data Set: K:\project\12020\2015 Pump Tests\MW 15-01\AQTESOLV\15_01_Moench_w_slab.aqt
Date: 01/22/18 Time: 09:09:07

PROJECT INFORMATION

Company: Hydrometrics
Project: 12020
Test Well: 15-01
Test Date: 6/17/15

AQUIFER DATA

Saturated Thickness: 59. ft Slab Block Thickness: 1. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-01	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ 15-01	0	0

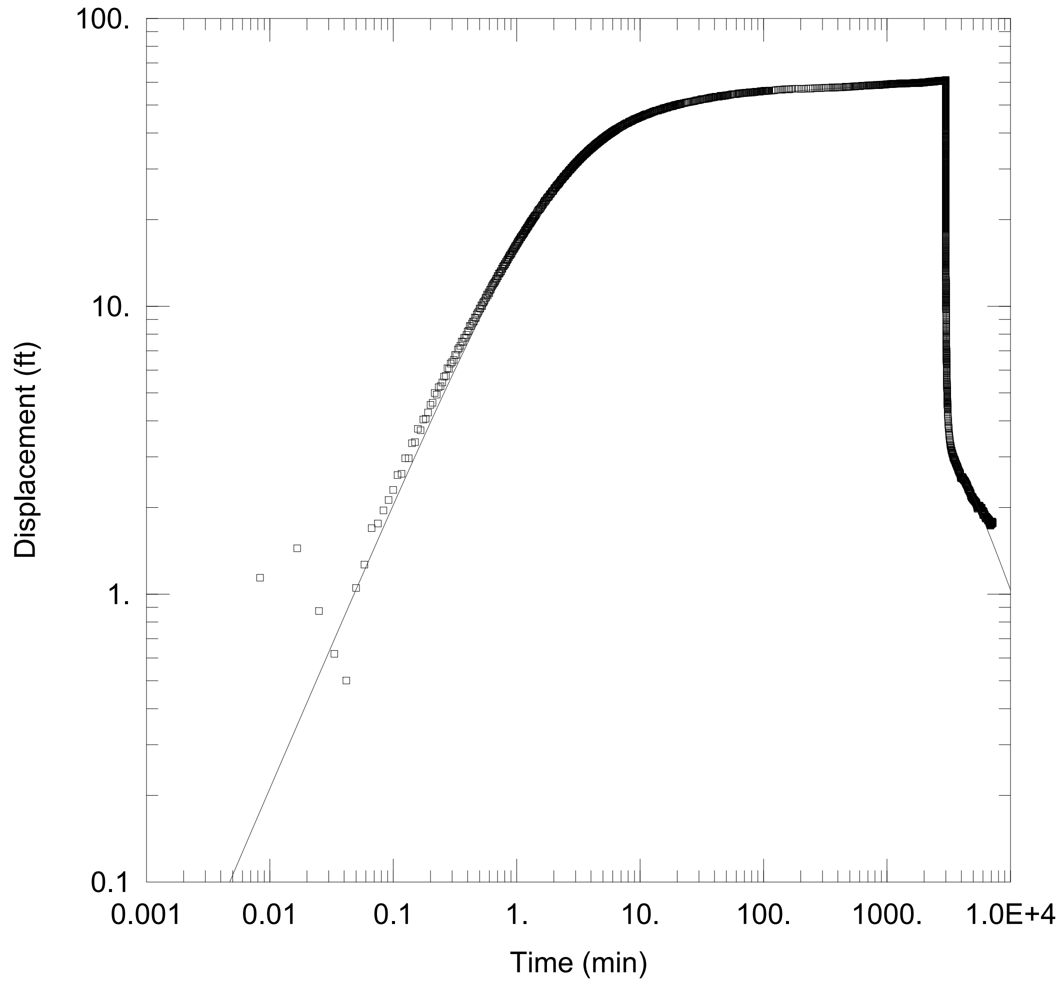
SOLUTION

Aquifer Model: Fractured

Solution Method: Moench w/slab blocks

K = 0.0002948 cm/sec
K' = 1.606E-9 cm/sec
Sw = 0.
r(w) = 0.4074 ft

Ss = 6.434E-7 ft^{-1}
Ss' = 3.162E-5 ft^{-1}
Sf = 1.25
r(c) = 0.1669 ft



WELL TEST ANALYSIS

Data Set: K:\project\12020\2015 Pump Tests\MW 15-01\AQTESOLV\15_01_Barker_slab.aqt
Date: 01/22/18 Time: 09:02:06

PROJECT INFORMATION

Company: Hydrometrics
Project: 12020
Test Well: 15-01
Test Date: 6/17/15

AQUIFER DATA

Saturated Thickness: 59. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-01	0	0

Observation Wells

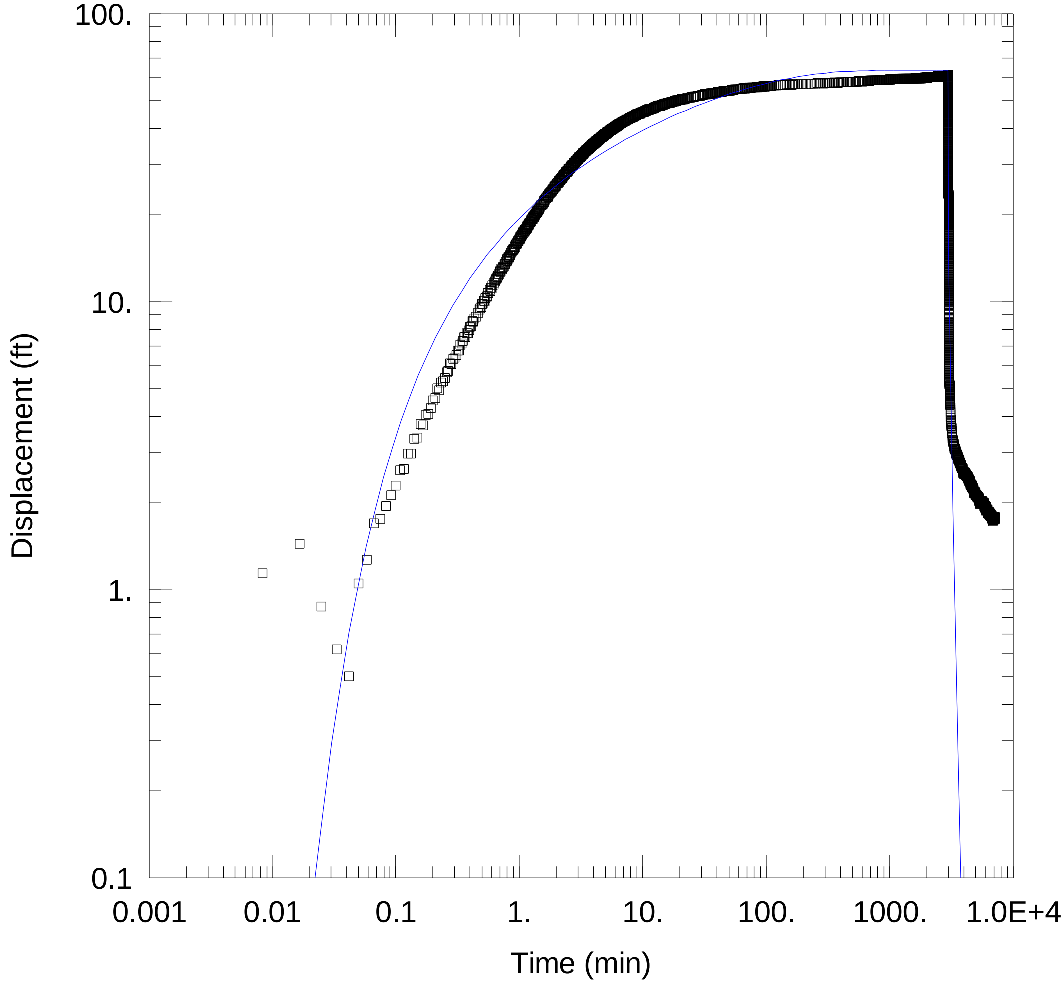
Well Name	X (ft)	Y (ft)
□ 15-01	0	0

SOLUTION

Aquifer Model: Fractured Solution Method: Barker

K = 0.0003555 cm/sec
K' = 4.528E-9 cm/sec
n = 2.06
Sf = 2.5
r(w) = 0.33 ft

Ss = 4.087E-6
Ss' = 2.512E-5 ft^{-1}
b = 59. ft
Sw = 0.675
r(c) = 0.1669 ft



WELL TEST ANALYSIS

Data Set: K:\project\12020\2015 Pump Tests\MW 15-01\AQTESOLV\15_01_Hantush_Jacob_Leaky.aqt
Date: 02/03/16 Time: 08:26:25

PROJECT INFORMATION

Company: Hydrometrics
Project: 12020
Test Well: 15-01
Test Date: 6/17/15

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-01	0	0

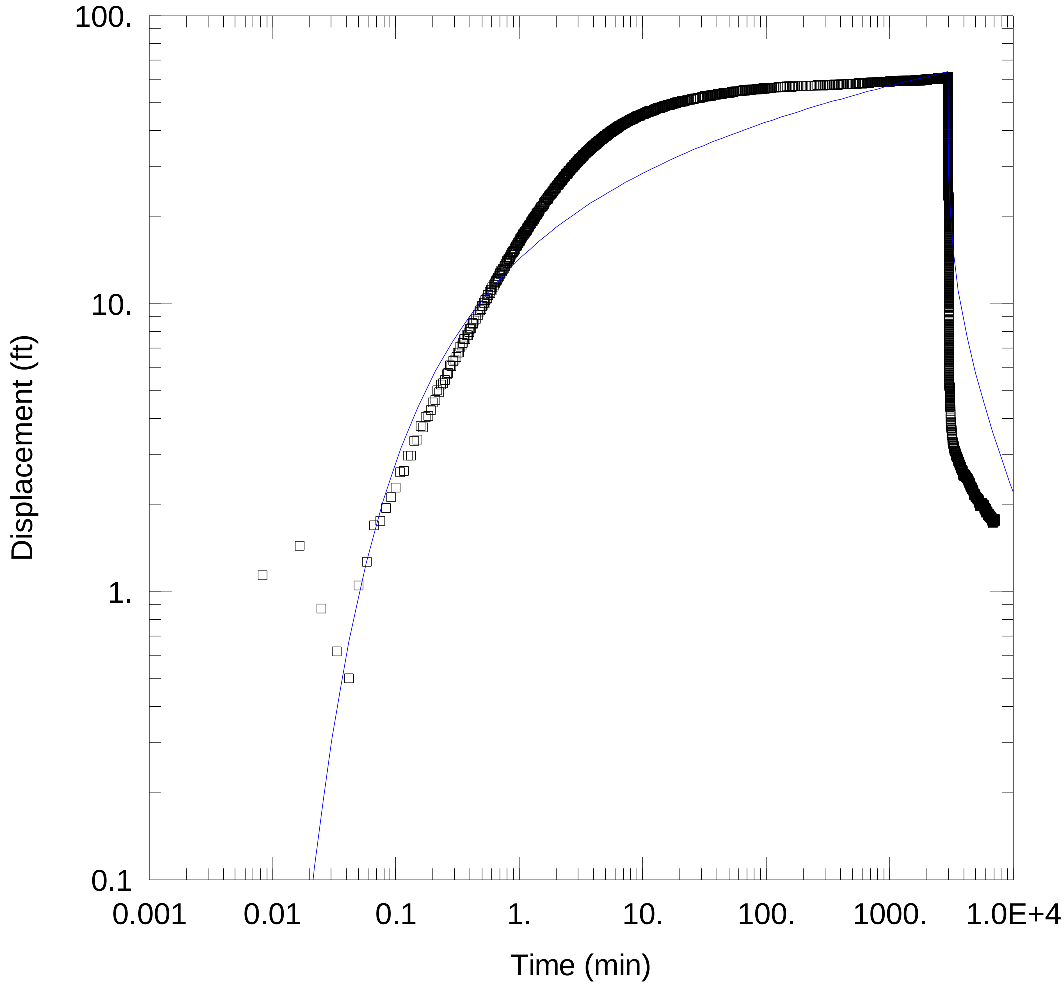
Observation Wells

Well Name	X (ft)	Y (ft)
□ 15-01	0	0

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

T = 0.2538 cm^2/sec
S = 0.004564
r/B = 0.03311
Kz/Kr = 0.3802
b = 59. ft



WELL TEST ANALYSIS

Data Set: K:\project\12020\2015 Pump Tests\MW 15-01\AQTESOLV\15_01_Theis.aqt
Date: 02/03/16 Time: 08:28:20

PROJECT INFORMATION

Company: Hydrometrics
Project: 12020
Test Well: 15-01
Test Date: 6/17/15

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-01	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ 15-01	0	0

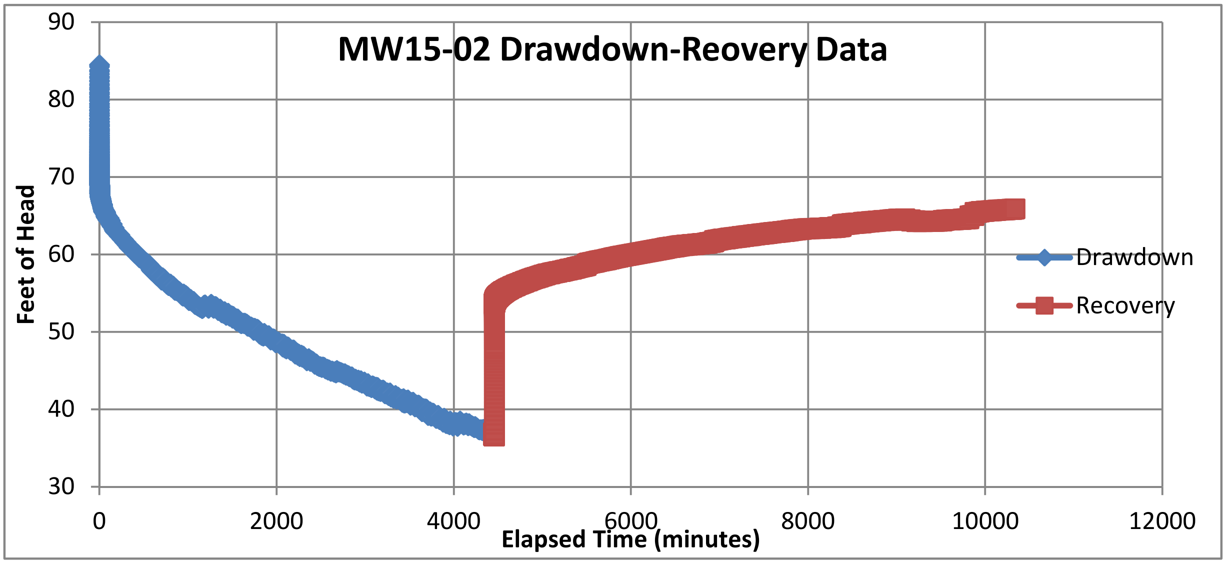
SOLUTION

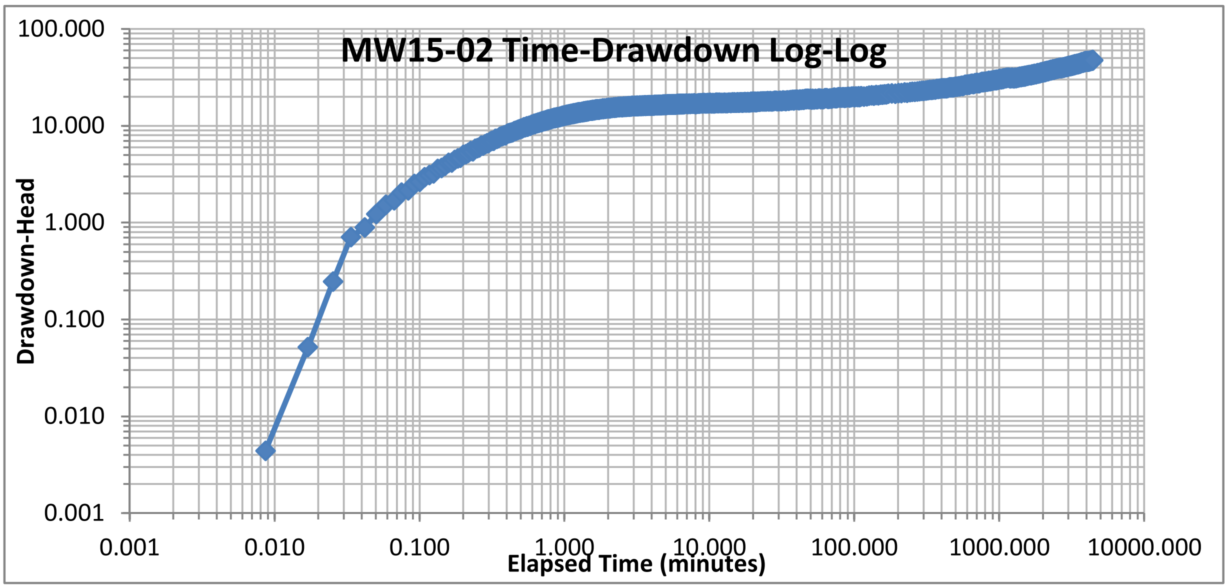
Aquifer Model: Confined

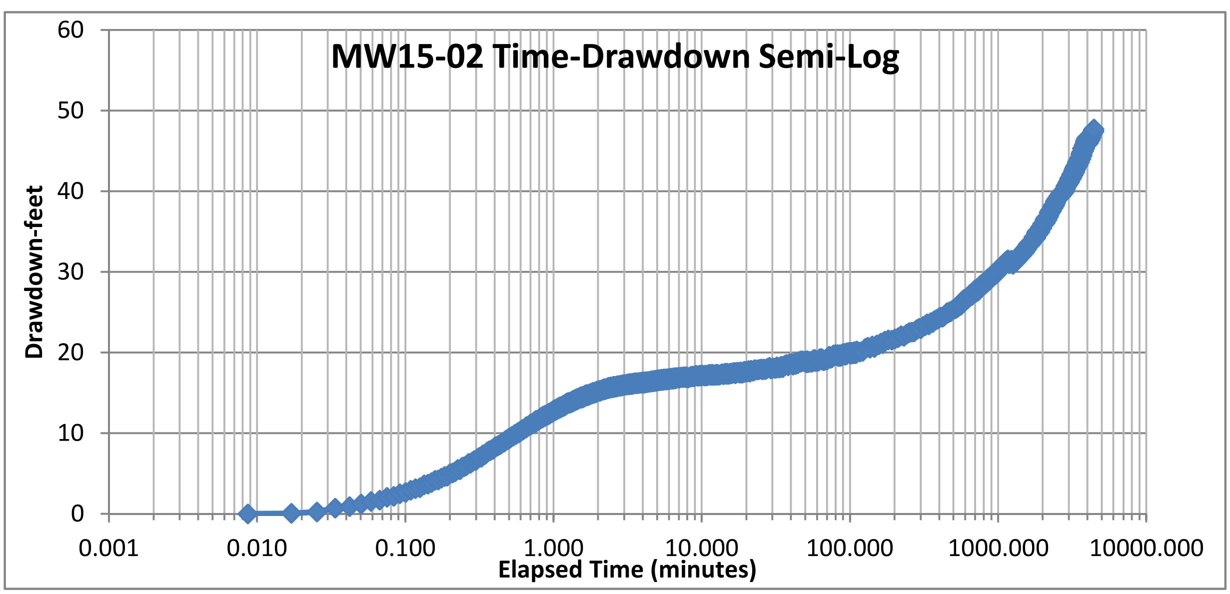
Solution Method: Theis

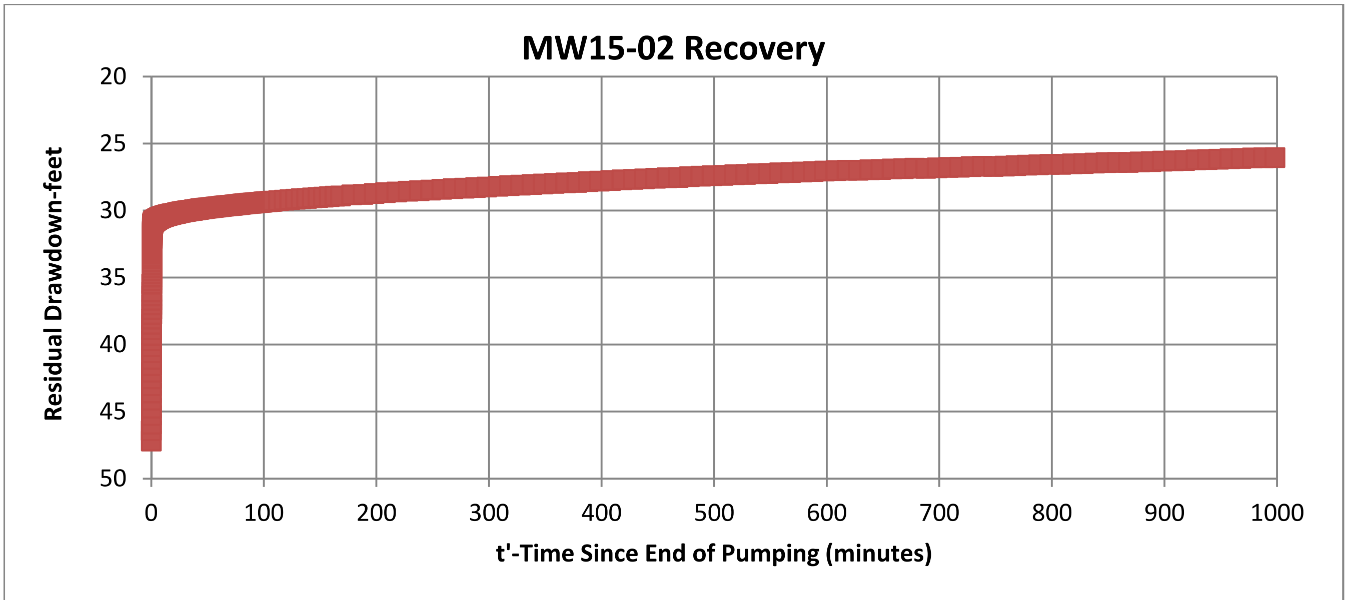
T = 0.3668 cm^2/sec
Kz/Kr = 0.0631

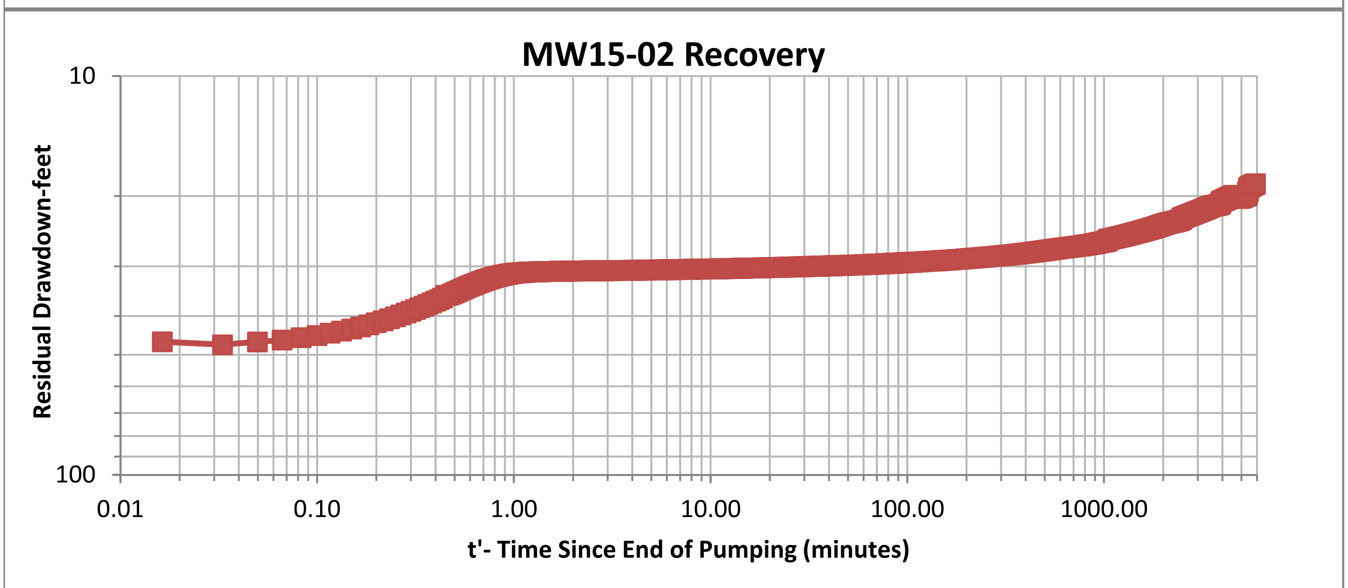
S = 0.005746
b = 59. ft

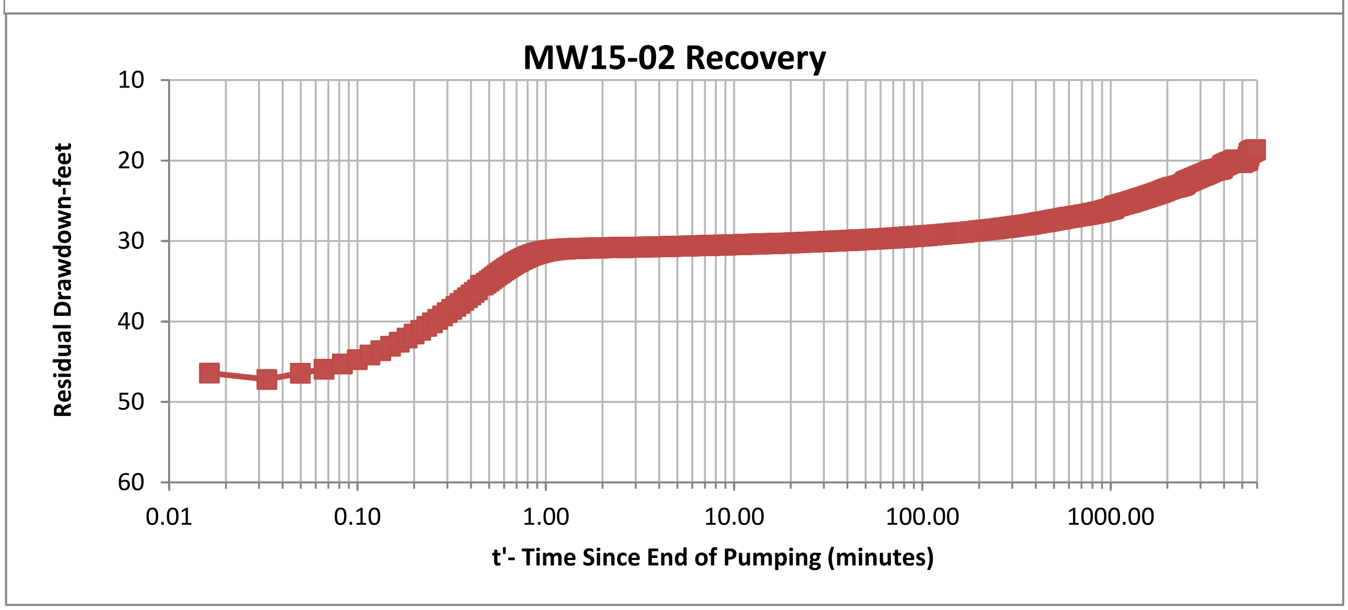

MW15-02 Drawdown-Reovery Data
Feet of Head
Elapsed Time (minutes)
Drawdown
Recovery
90
80
70
60
50
40
30
0
2000
4000
6000
8000
10000
12000

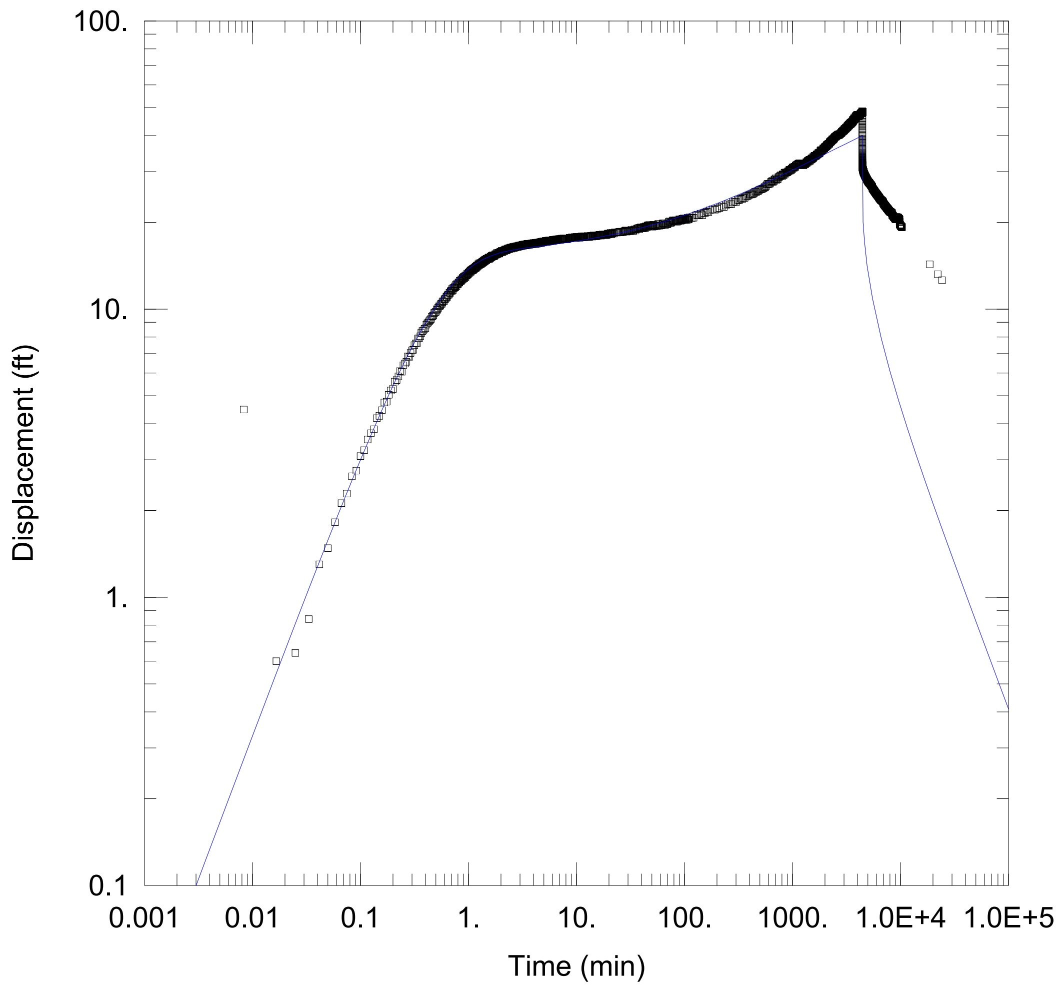

MW15-02 Time-Drawdown Log-Log
Drawdown-Head
Elapsed Time (minutes)
100.000
10.000
1.000
0.100
0.010
0.001
0.001
0.010
0.100
1.000
10.000
100.000
1000.000
10000.000


MW15-02 Time-Drawdown Semi-Log
Drawdown-feet
Elapsed Time (minutes)
60
50
40
30
20
10
0
0.001
0.010
0.100
1.000
10.000
100.000
1000.000
10000.000


MW15-02 Recovery
Residual Drawdown-feet
20
25
30
35
40
45
50
0
100
200
300
400
500
600
700
800
900
1000
t'-Time Since End of Pumping (minutes)


MW15-02 Recovery
Residual Drawdown-feet
10
100
0.01
0.10
1.00
10.00
100.00
1000.00
t'- Time Since End of Pumping (minutes)


MW15-02 Recovery
Residual Drawdown-feet
10
20
30
40
50
60
0.01
0.10
1.00
10.00
100.00
1000.00
t'- Time Since End of Pumping (minutes)



WELL TEST ANALYSIS

Data Set: K:\project\12020\2015 Pump Tests\MW 15-02\AQTESOLV\15_02_Moench_slab.aqt
Date: 01/22/18 Time: 09:47:43

PROJECT INFORMATION

Company: Hydrometrics
Project: 12020
Test Well: 15-02
Test Date: 6/23/15

AQUIFER DATA

Saturated Thickness: 75. ft
Slab Block Thickness: 1. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-02	0	0

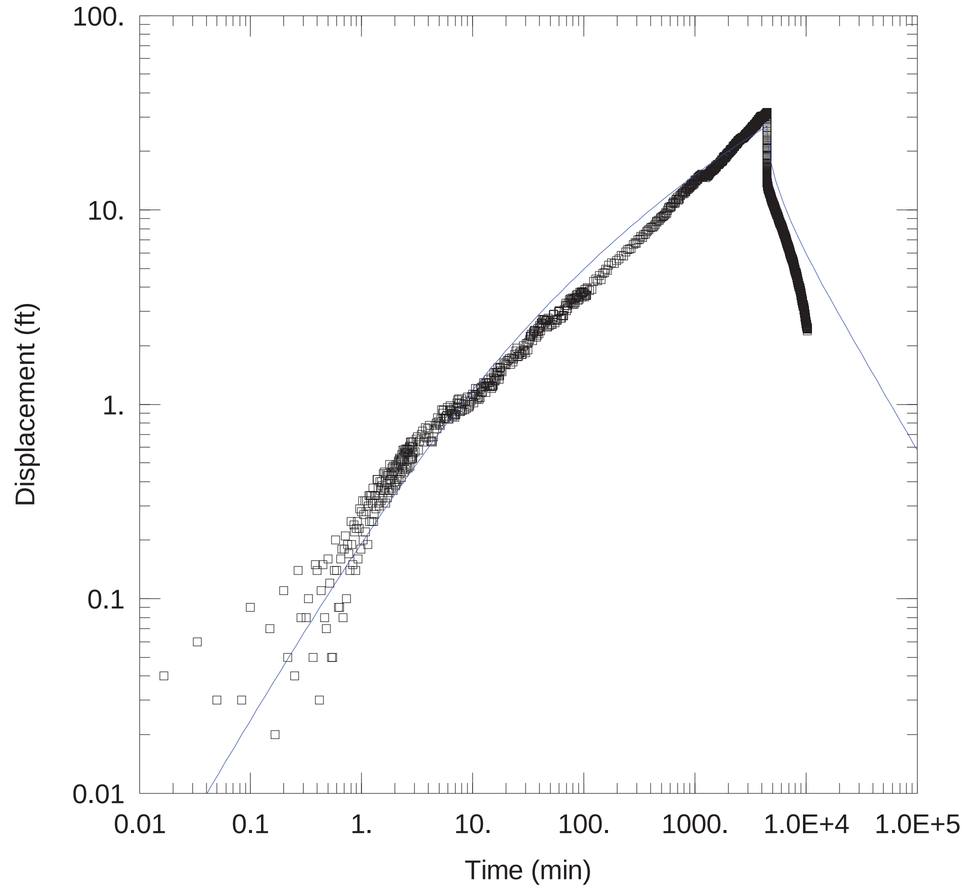
Observation Wells

Well Name	X (ft)	Y (ft)
▫ 15-02	0	0

SOLUTION

Aquifer Model: Fractured
Solution Method: Moench w/slab blocks

K = 0.0001699 cm/sec
K' = 5.898E-7 cm/sec
Sw = 0.825
r(w) = 0.1667 ft
Ss = 11.41 ft^{-1}
Ss' = 1.83E-10 ft^{-1}
Sf = 3.
r(c) = 0.1669 ft



WELL TEST ANALYSIS

Data Set: K:\project\12020\2015 Pump Tests\MW 15-02\AQTESOLV\15_02_Moench.aqt
Date: 02/03/16 Time: 08:36:57

PROJECT INFORMATION

Company: Hydrometrics
Project: 12020
Test Well: 15-02
Test Date: 6/23/15

AQUIFER DATA

Saturated Thickness: 75. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-02	0	0

Observation Wells

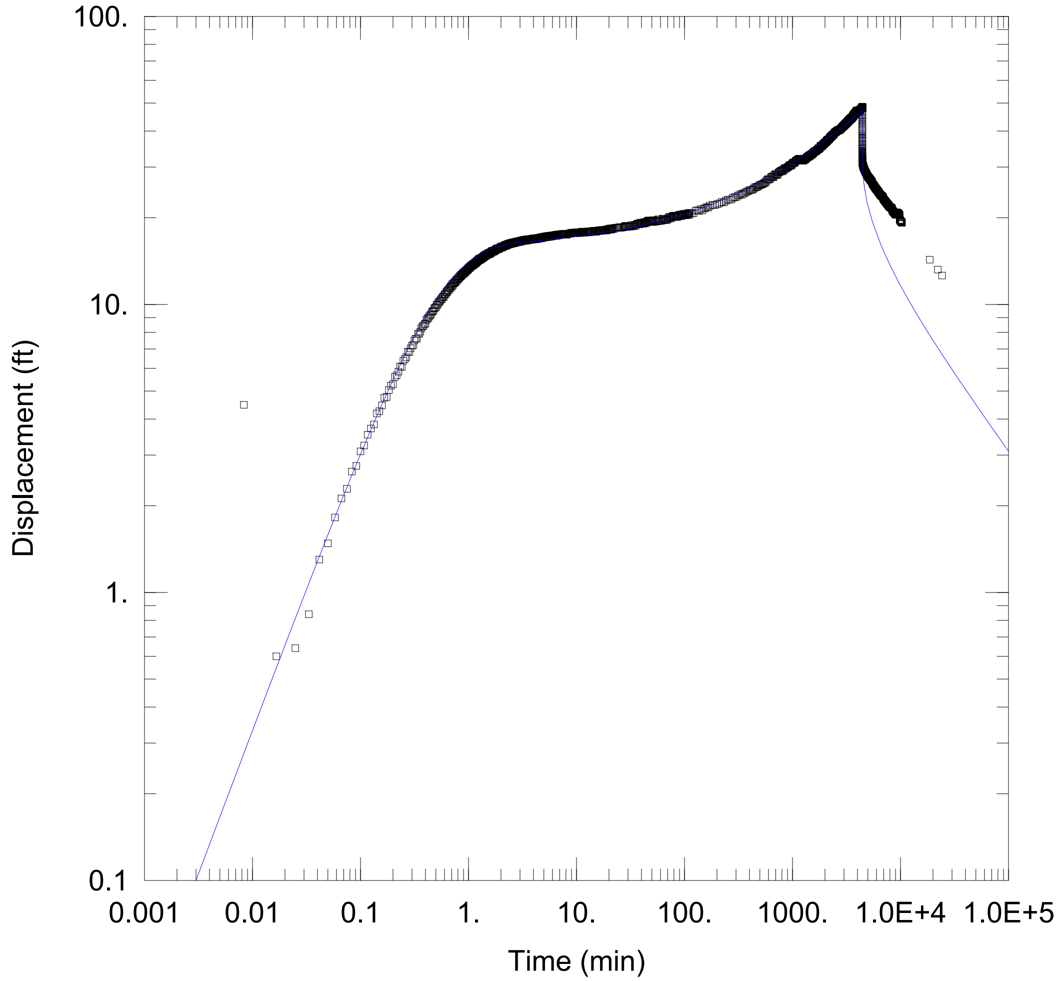
Well Name	X (ft)	Y (ft)
□ 15-02	0	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Moench

T = 0.2662 cm^2/sec
Sy = 0.002402
Sw = -2.475
r(c) = 1.873 ft

S = 10.16
ß = 4.899E-6
r(w) = 0.166 ft
alpha = 6.31E+22 min^{-1}



WELL TEST ANALYSIS

Data Set: K:\project\12020\2015 Pump Tests\MW 15-02\AQTESOLV\15_02_Barker_slab.aqt
Date: 01/22/18 Time: 09:15:28

PROJECT INFORMATION

Company: Hydrometrics
Project: 12020
Test Well: 15-02
Test Date: 6/23/15

AQUIFER DATA

Saturated Thickness: 75. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-02	0	0

Observation Wells

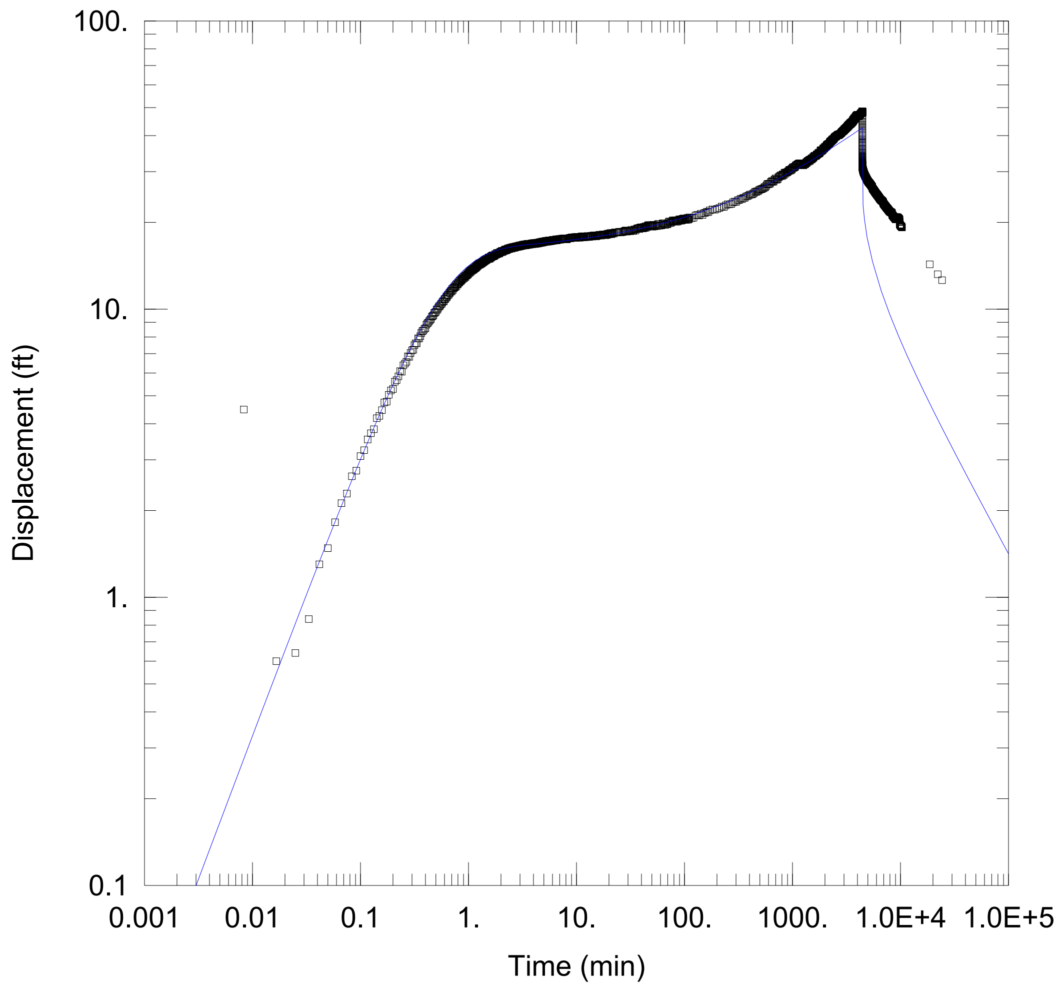
Well Name	X (ft)	Y (ft)
▫ 15-02	0	0

SOLUTION

Aquifer Model: Fractured
Solution Method: Barker

K = 7.79E-6 cm/sec
K' = 1.802E-5 cm/sec
n = 1.04
Sf = 3.85
r(w) = 0.1666 ft

Ss = 0.0312
Ss' = 0.001 ft^{-1}
b = 75. ft
Sw = 4.65
r(c) = 0.1666 ft



WELL TEST ANALYSIS

Data Set: K:\project\12020\2015 Pump Tests\MW 15-02\AQTESOLV\15_02_Barker.aqt
Date: 01/22/18 Time: 09:12:29

PROJECT INFORMATION

Company: Hydrometrics
Project: 12020
Test Well: 15-02
Test Date: 6/23/15

AQUIFER DATA

Saturated Thickness: 75. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-02	0	0

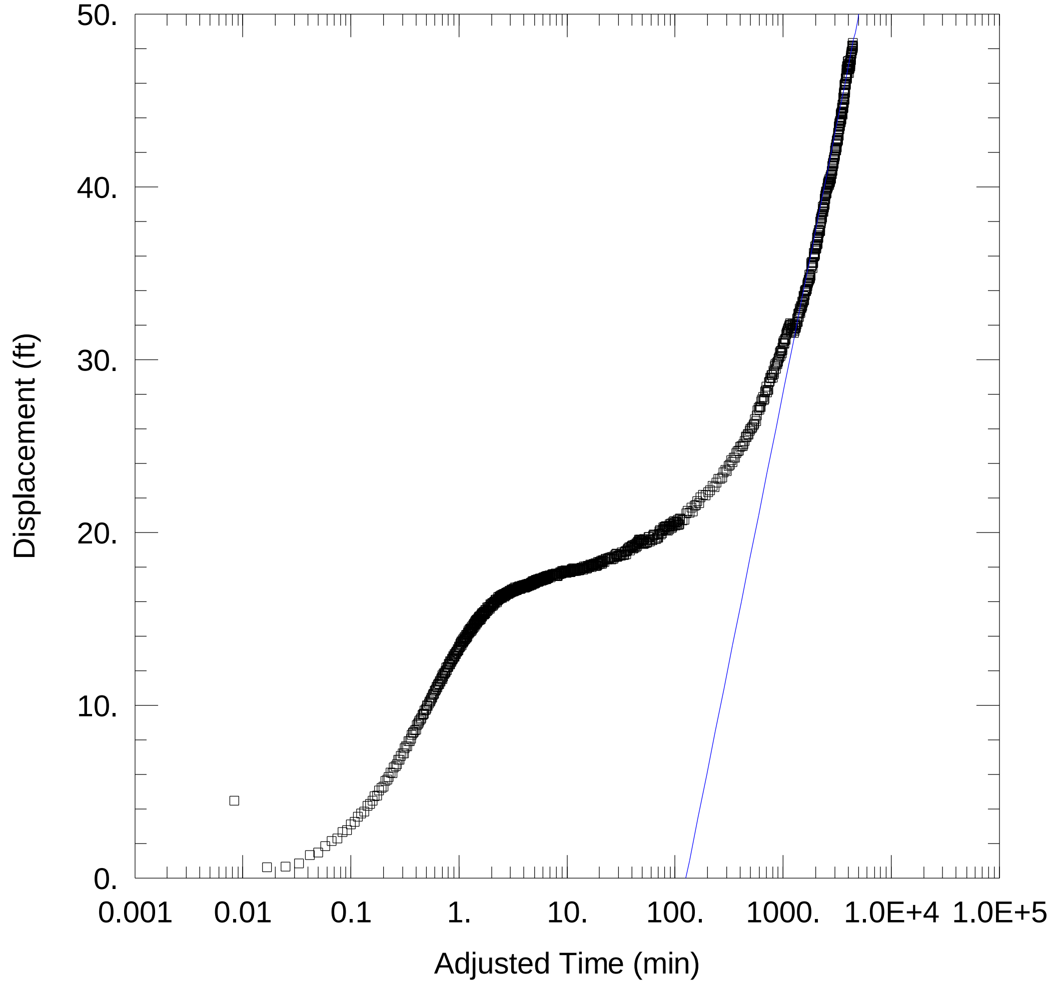
Observation Wells

Well Name	X (ft)	Y (ft)
▫ 15-02	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Barker

K = 1.221E-5 cm/sec
n = 1.385
Sw = 1.425
r(c) = 0.1669 ft
Ss = 0.4959
b = 75. ft
r(w) = 0.166 ft



WELL TEST ANALYSIS

Data Set: K:\project\12020\2015 Pump Tests\MW 15-02\AQTESOLV\15_02_Cooper_Jacob.aqt
Date: 02/09/16 Time: 14:56:38

PROJECT INFORMATION

Company: Hydrometrics
Project: 12020
Test Well: 15-02
Test Date: 6/23/15

AQUIFER DATA

Saturated Thickness: 75. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
15-02	0	0

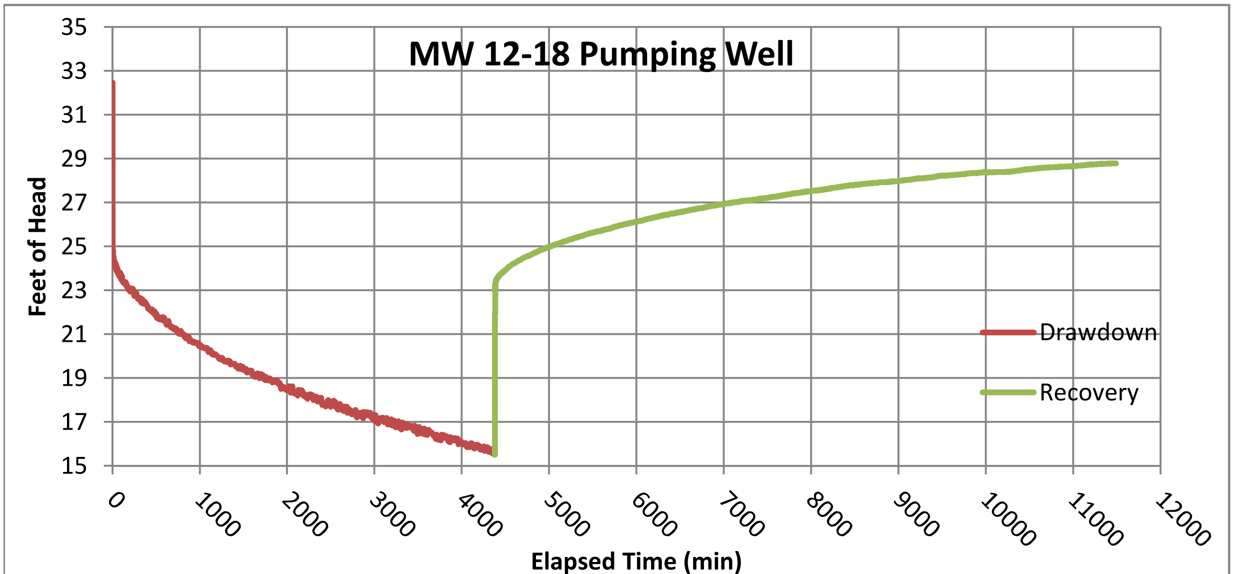
Observation Wells

Well Name	X (ft)	Y (ft)
□ 15-02	0	0

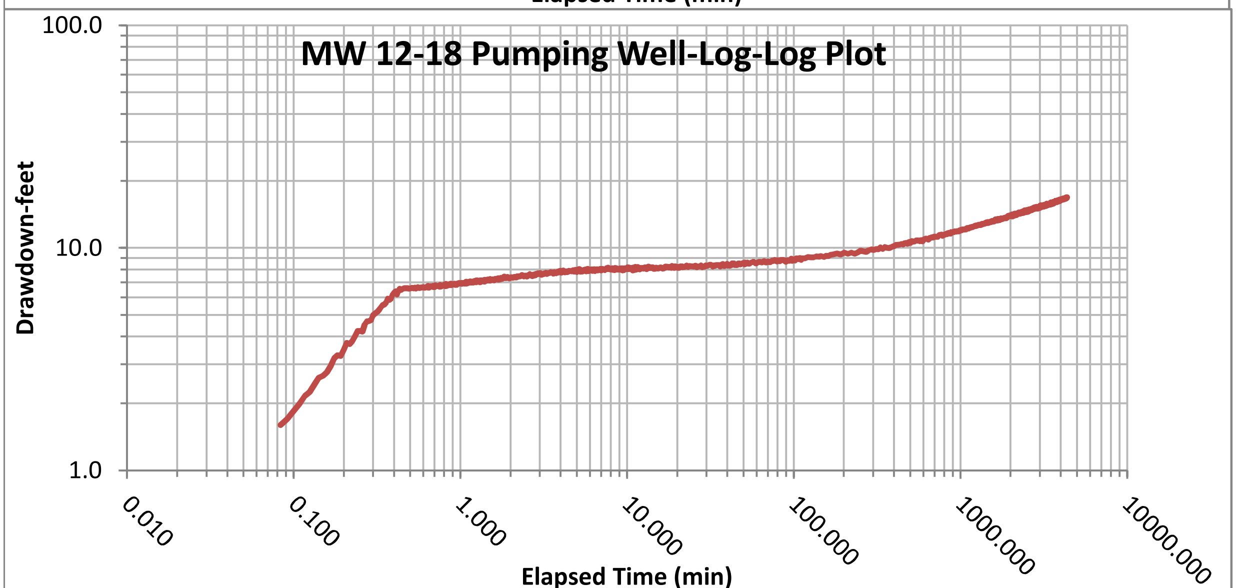
SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Jacob

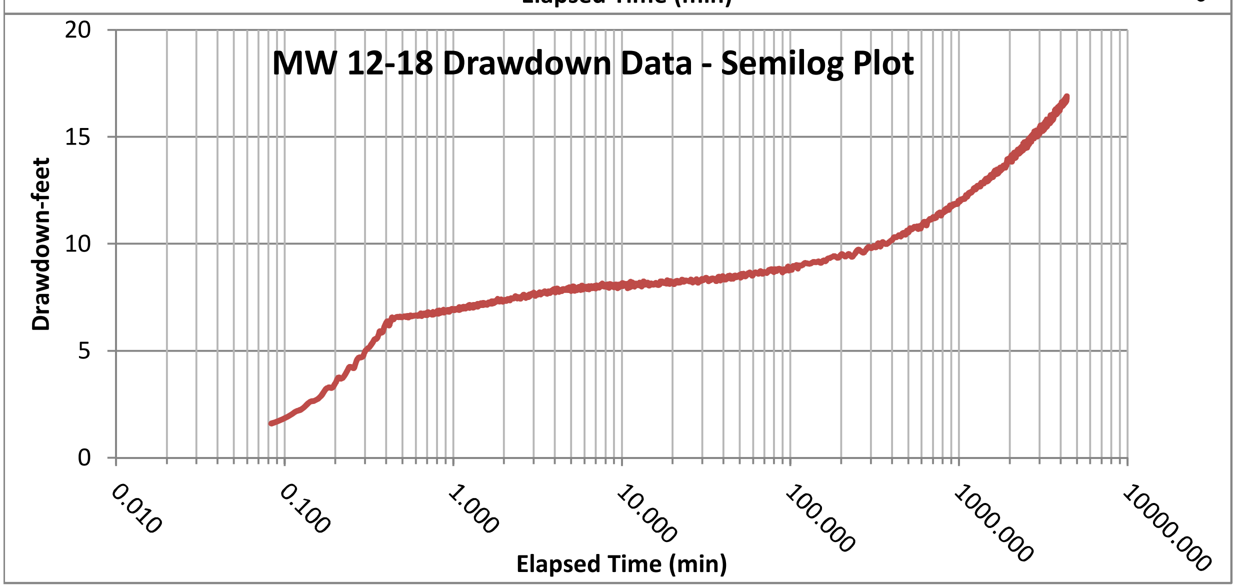
T = 0.2646 cm^2/sec S = 66.86



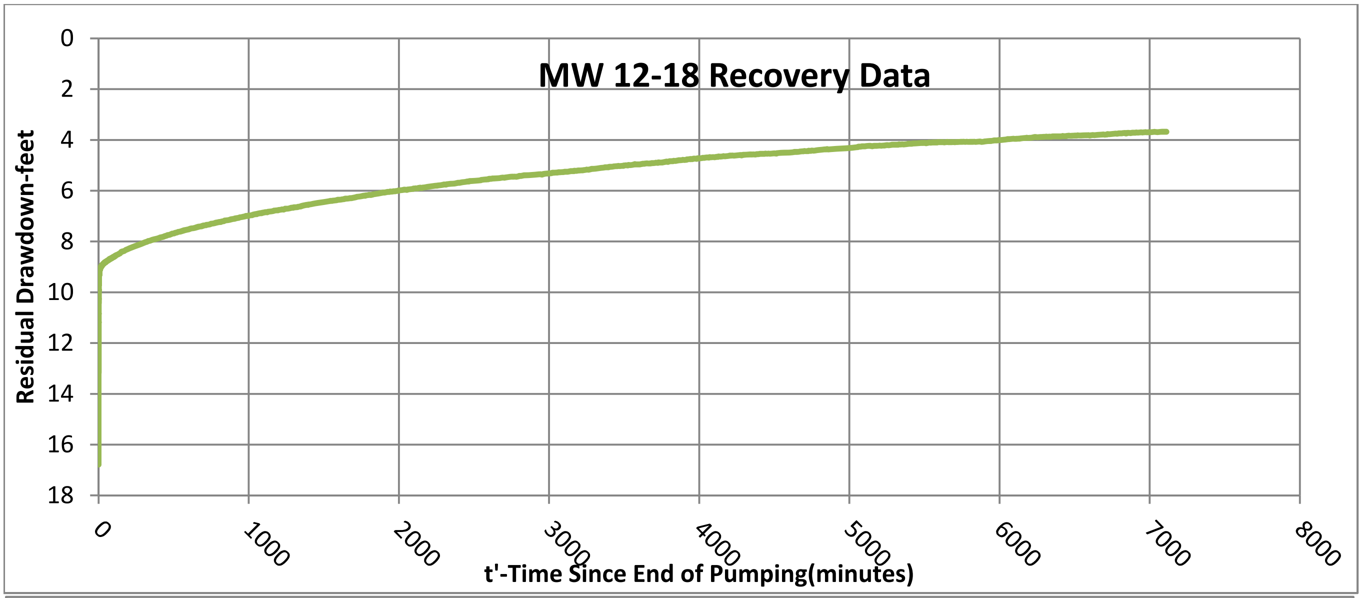
MW 12-18 Pumping Well
Feet of Head
35
33
31
29
27
25
23
21
19
17
15
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
Elapsed Time (min)
Drawdown
Recovery

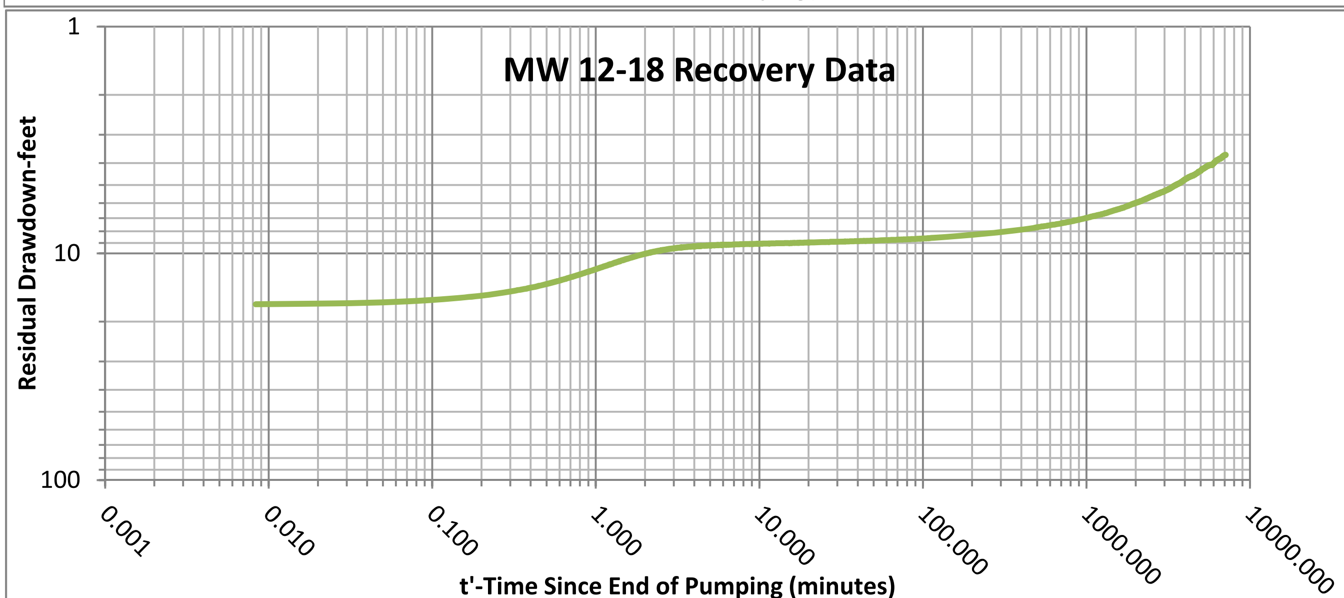


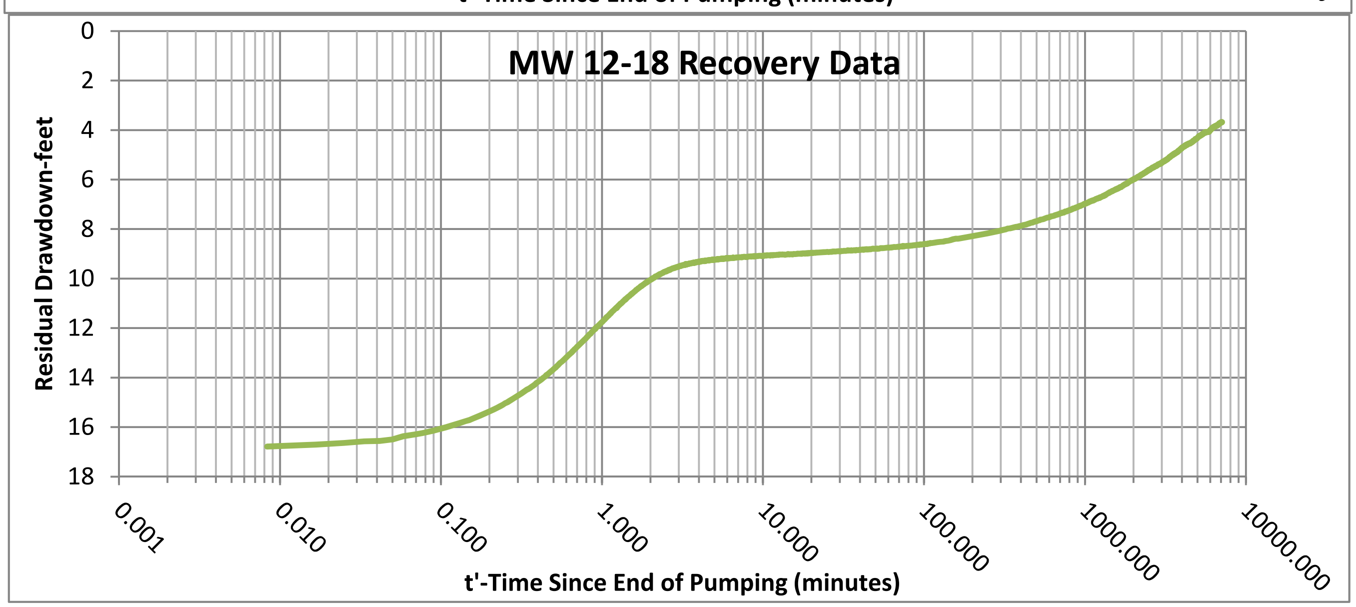
MW 12-18 Pumping Well-Log-Log Plot
Drawdown-feet
100.0
10.0
1.0
0.010
0.100
1.000
10.000
100.000
1000.000
10000.000
Elapsed Time (min)

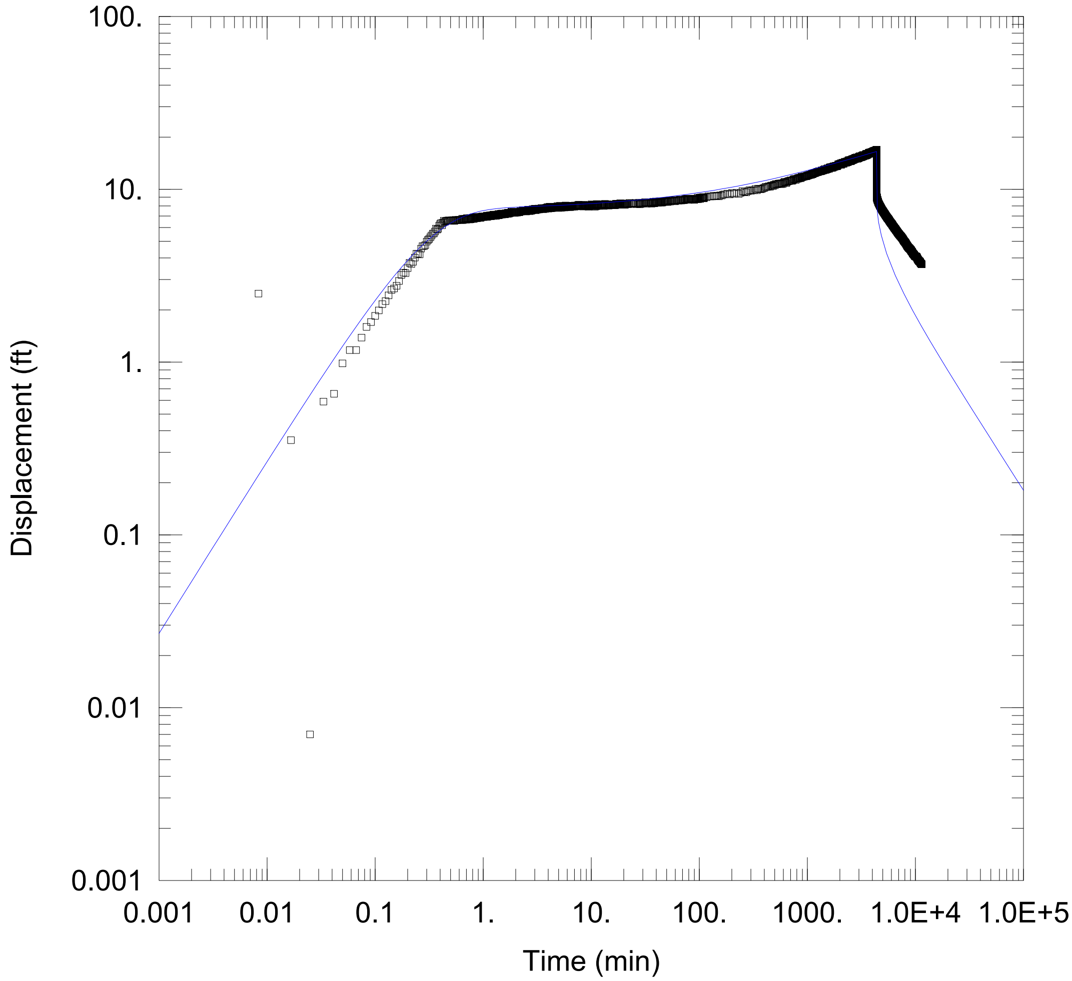


MW 12-18 Drawdown Data - Semilog Plot
Drawdown-feet
20
15
10
5
0
0.010
0.100
1.000
10.000
100.000
1000.000
10000.000
Elapsed Time (min)


MW 12-18 Recovery Data
Residual Drawdown-feet
0
2
4
6
8
10
12
14
16
18
0
1000
2000
3000
4000
5000
6000
7000
8000
t'-Time Since End of Pumping(minutes)


MW 12-18 Recovery Data
Residual Drawdown-feet
1
10
100
0.001
0.010
0.100
1.000
10.000
100.000
1000.000
10000.000
t'-Time Since End of Pumping (minutes)


MW 12-18 Recovery Data
Residual Drawdown-feet
0
2
4
6
8
10
12
14
16
18
0.001
0.010
0.100
1.000
10.000
100.000
1000.000
10000.000
t'-Time Since End of Pumping (minutes)



WELL TEST ANALYSIS

Data Set: K:\project\12020\2015 Pump Tests\MW 12-18\AQTESOLV\12_18_Moench_w_Slab_gtb.aqt
Date: 01/22/18 Time: 09:53:19

PROJECT INFORMATION

Company: Hydrometrics
Project: 12020
Test Well: 12-08
Test Date: 6/23/15

AQUIFER DATA

Saturated Thickness: 53. ft Slab Block Thickness: 1. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
12-18	0	0

Observation Wells

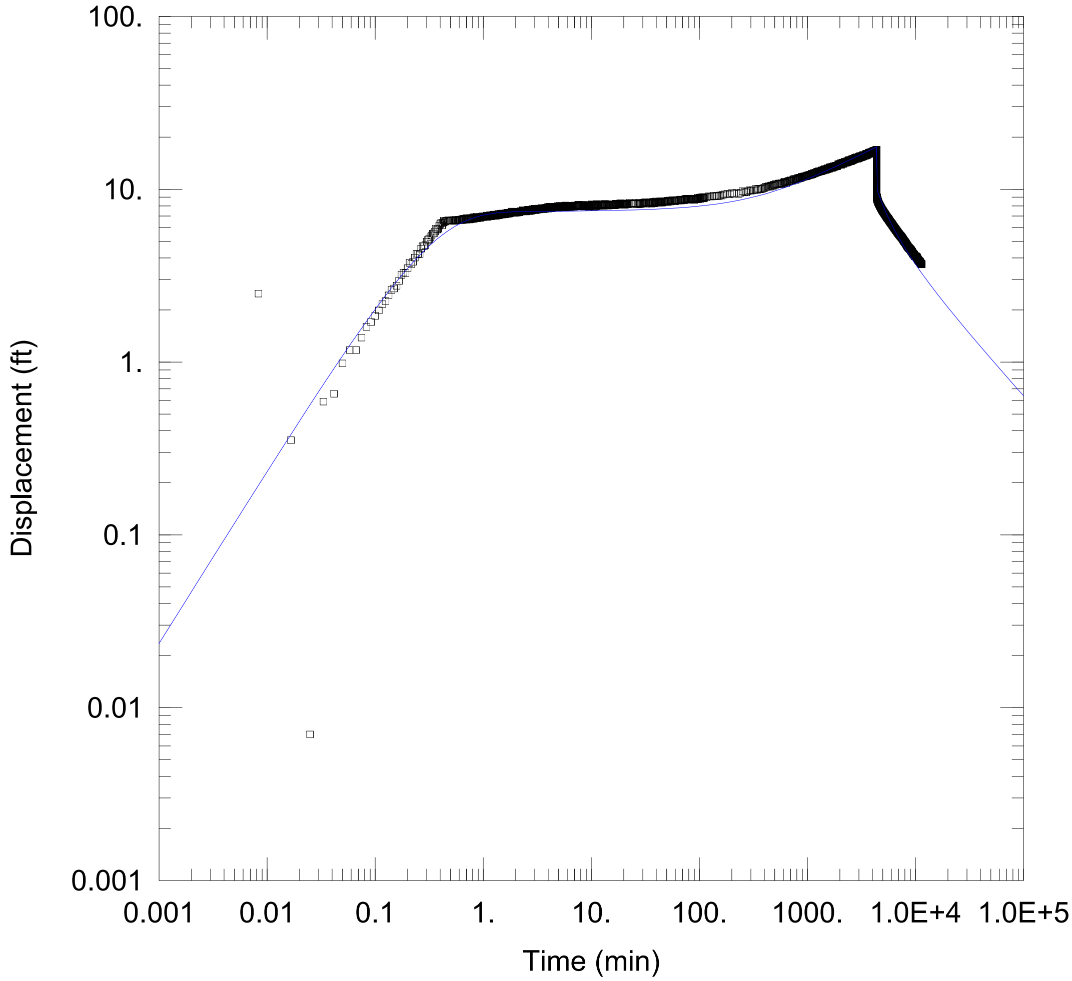
Well Name	X (ft)	Y (ft)
□ 12-18	0	0

SOLUTION

Aquifer Model: Fractured Solution Method: Moench w/slab blocks

K = 0.0001612 cm/sec
K' = 5.142E-6 cm/sec
Sw = 0.9
r(w) = 0.1666 ft

Ss = 23.13 ft^{-1}
Ss' = 3.35E-6 ft^{-1}
Sf = 6.35
r(c) = 0.1029 ft



WELL TEST ANALYSIS

Data Set: K:\project\12020\2015 Pump Tests\MW 12-18\AQTESOLV\12_18_Barker_Slab.aqt
Date: 01/22/18 Time: 09:51:50

PROJECT INFORMATION

Company: Hydrometrics
Project: 12020
Test Well: 12-08
Test Date: 6/23/15

AQUIFER DATA

Saturated Thickness: 78. ft Anisotropy Ratio (Kz/Kr): 2.192E+4

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
12-18	0	0

Observation Wells

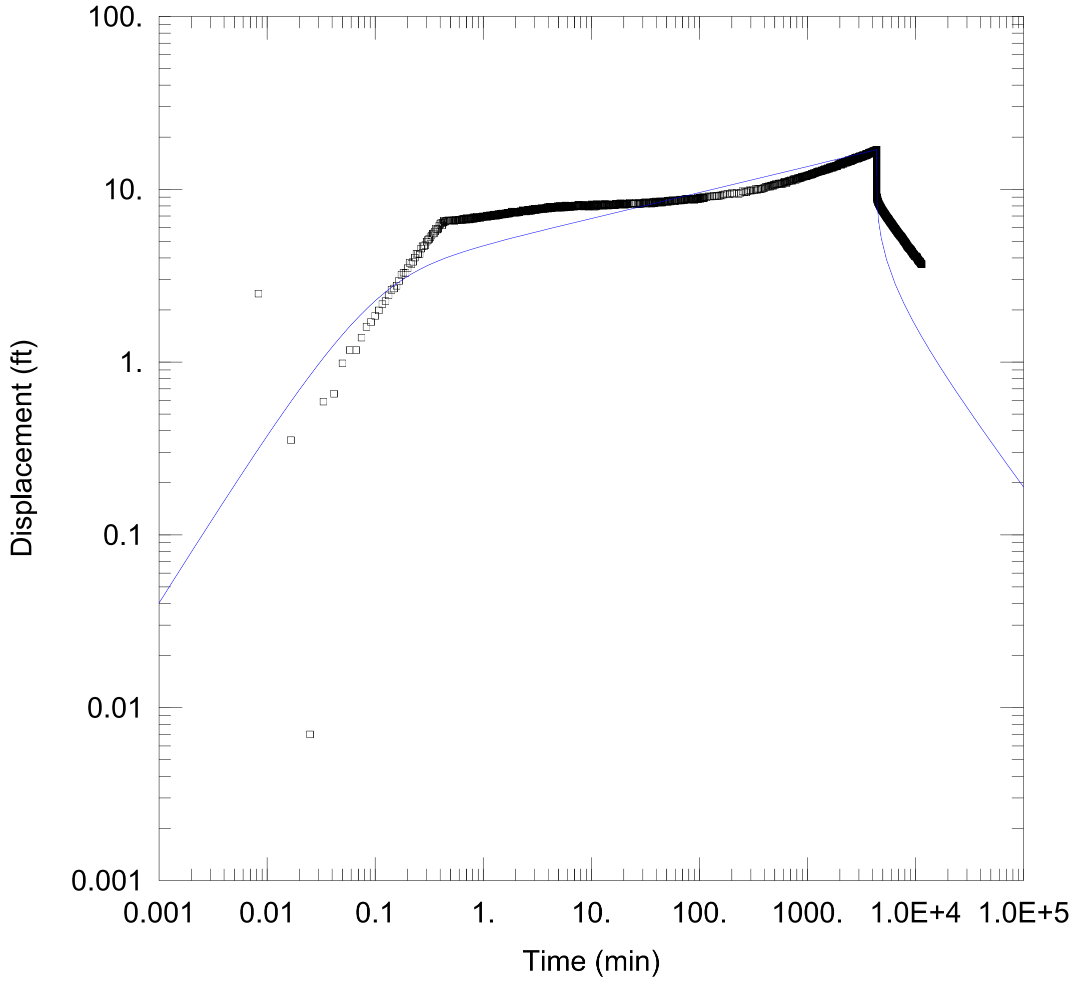
Well Name	X (ft)	Y (ft)
□ 12-18	0	0

SOLUTION

Aquifer Model: Fractured Solution Method: Barker

K = 0.000131 cm/sec
K' = 1.432E-6 cm/sec
n = 1.385
Sf = 8.5
r(w) = 0.1666 ft

Ss = 9.154E-12
Ss' = 0.0005623 ft^{-1}
b = 78. ft
Sw = 0.1
r(c) = 0.1101 ft



WELL TEST ANALYSIS

Data Set: K:\project\12020\2015 Pump Tests\MW 12-18\AQTESOLV\12_18_Barker.aqt
Date: 01/22/18 Time: 09:49:47

PROJECT INFORMATION

Company: Hydrometrics
Project: 12020
Test Well: 12-08
Test Date: 6/23/15

AQUIFER DATA

Saturated Thickness: 53. ft Anisotropy Ratio (Kz/Kr): 0.4519

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
12-18	0	0

Observation Wells

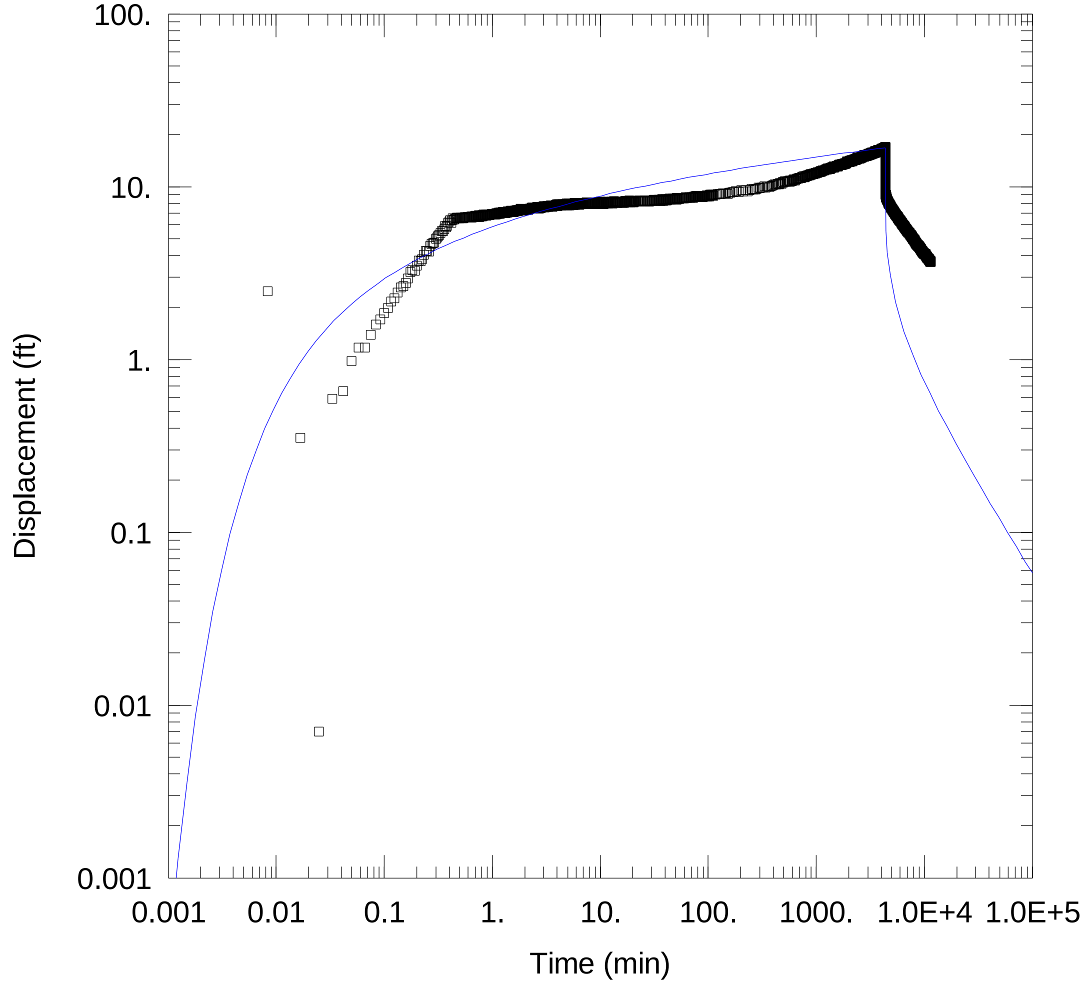
Well Name	X (ft)	Y (ft)
□ 12-18	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Barker

K = 0.001096 cm/sec
n = 1.685
Sw = 4.95
r(c) = 0.08365 ft

Ss = 4.953E-6
b = 53. ft
r(w) = 0.1666 ft



WELL TEST ANALYSIS

Data Set: K:\project\12020\2015 Pump Tests\MW 12-18\AQTESOLV\12_18_Theis.aqt
Date: 02/03/16 Time: 08:57:07

PROJECT INFORMATION

Company: Hydrometrics
Project: 12020
Test Well: 12-08
Test Date: 6/23/15

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
12-18	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ 12-18	0	0

SOLUTION

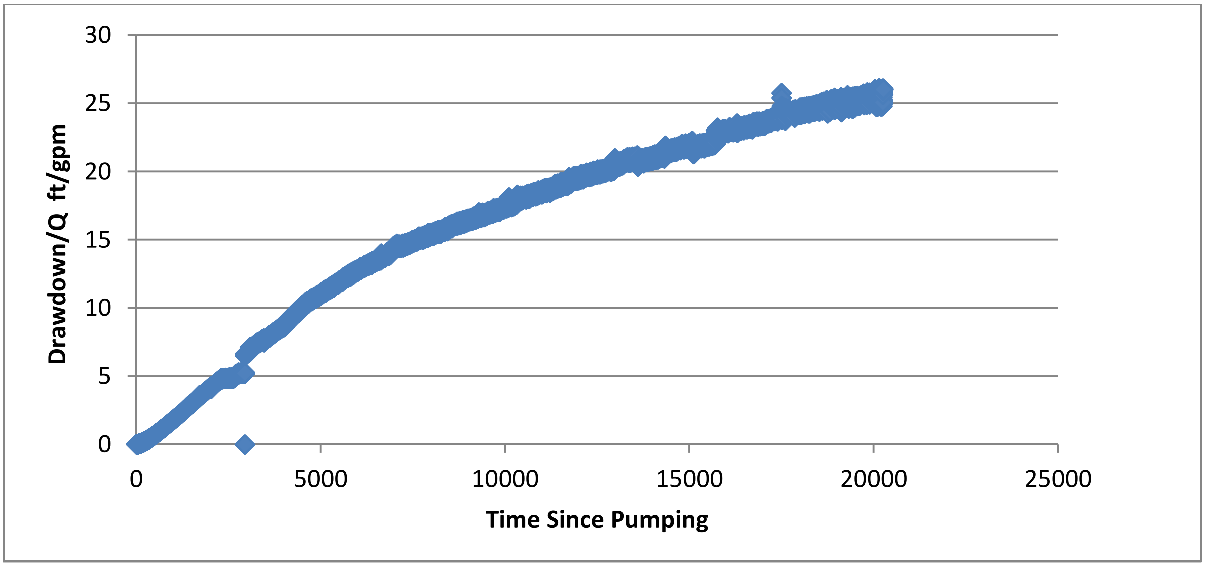
Aquifer Model: Confined
Solution Method: Theis

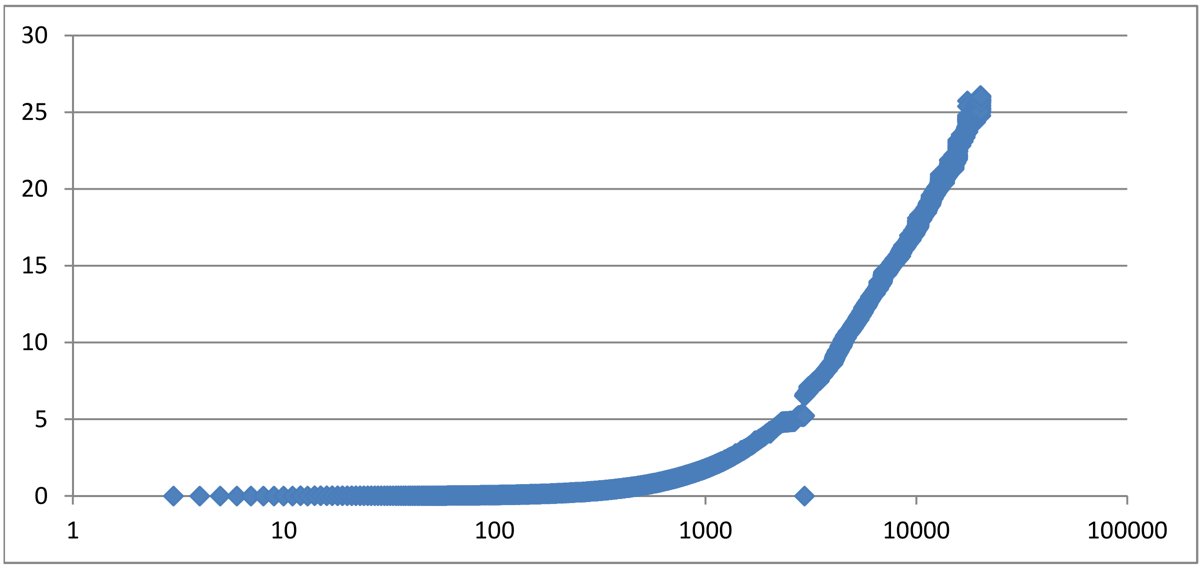
T = 0.8476 cm^2/sec
S = 0.05002
Kz/Kr = 0.4519
b = 53. ft

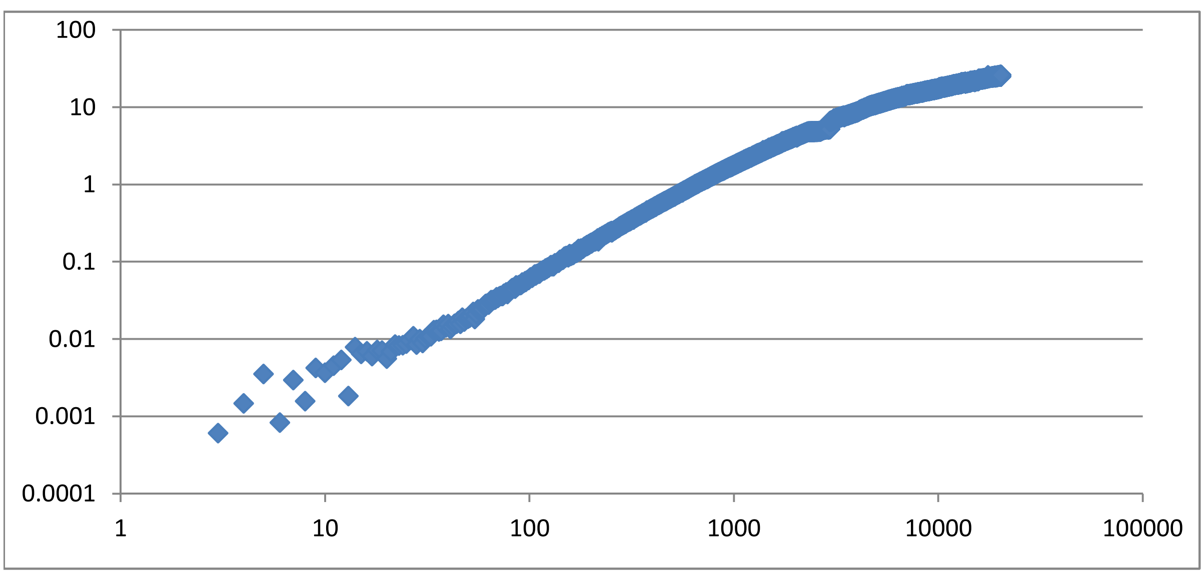
APPENDIX C-2

DEEP ISOLATED FRACTURE SYSTEM LONG-TERM PUMPING TEST

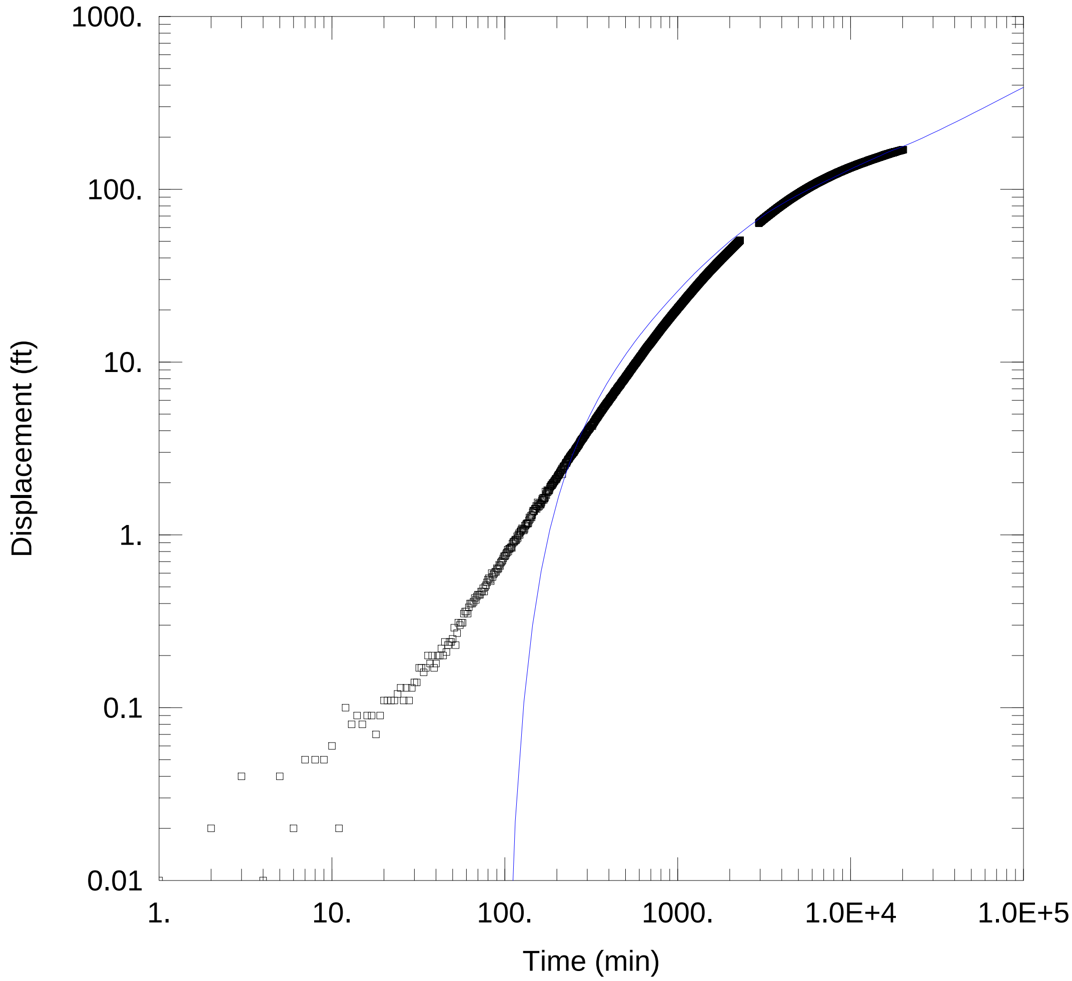
DIAGNOSTIC CURVES AND AQTESOLVE CURVE MATCHING PLOTS







MW16-01 LONG-TERM PUMPING TEST - DRAWDOWN/PUMPING RATE VERSES TIME



MW16-01 DRAWDOWN

Data Set: K:\...\MW1601 Drawdown Theis.aqt
Date: 03/21/17 Time: 12:11:09

PROJECT INFORMATION

Company: Hydrometrics
Client: MT Resources
Project: 12020
Location: YDTI
Test Well: MW16-02D
Test Date: 8/17/16

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
MW16-02D	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
MW16-01	-255	8

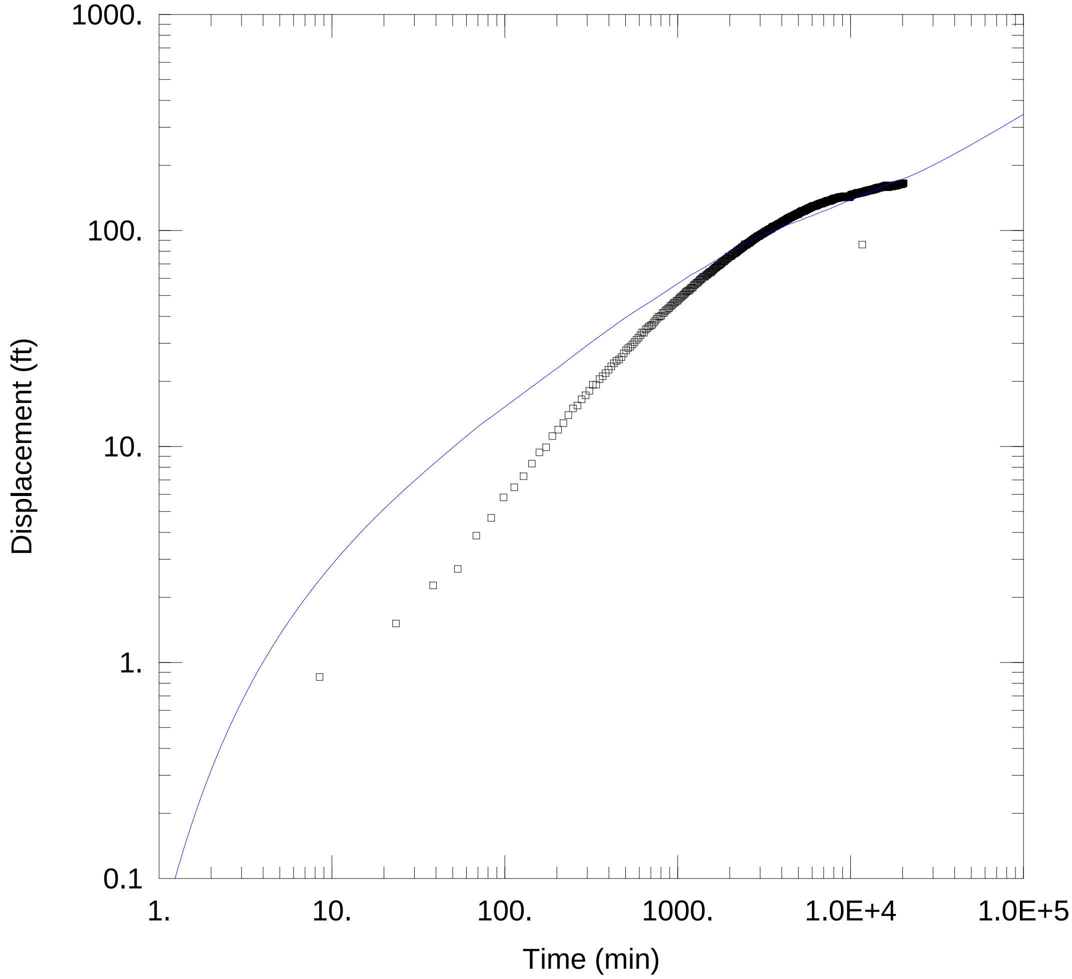
SOLUTION

Aquifer Model: Confined

Solution Method: Theis

T = 115.7 ft^2/day
Kz/Kr = 1.

S = 0.0008006
b = 100. ft



WELL TEST ANALYSIS

Data Set: K:\project\12020\1602D_PumpTest\AQTESOLV\March 2017 Analyses\DH 15-14_VW2_Theis.aqt
Date: 03/21/17 Time: 12:09:08

PROJECT INFORMATION

Company: Hydrometrics
Project: 12020
Location: Montana Resources
Test Well: MW-16-02D
Test Date: Forward

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
MW-1602 D	0	0

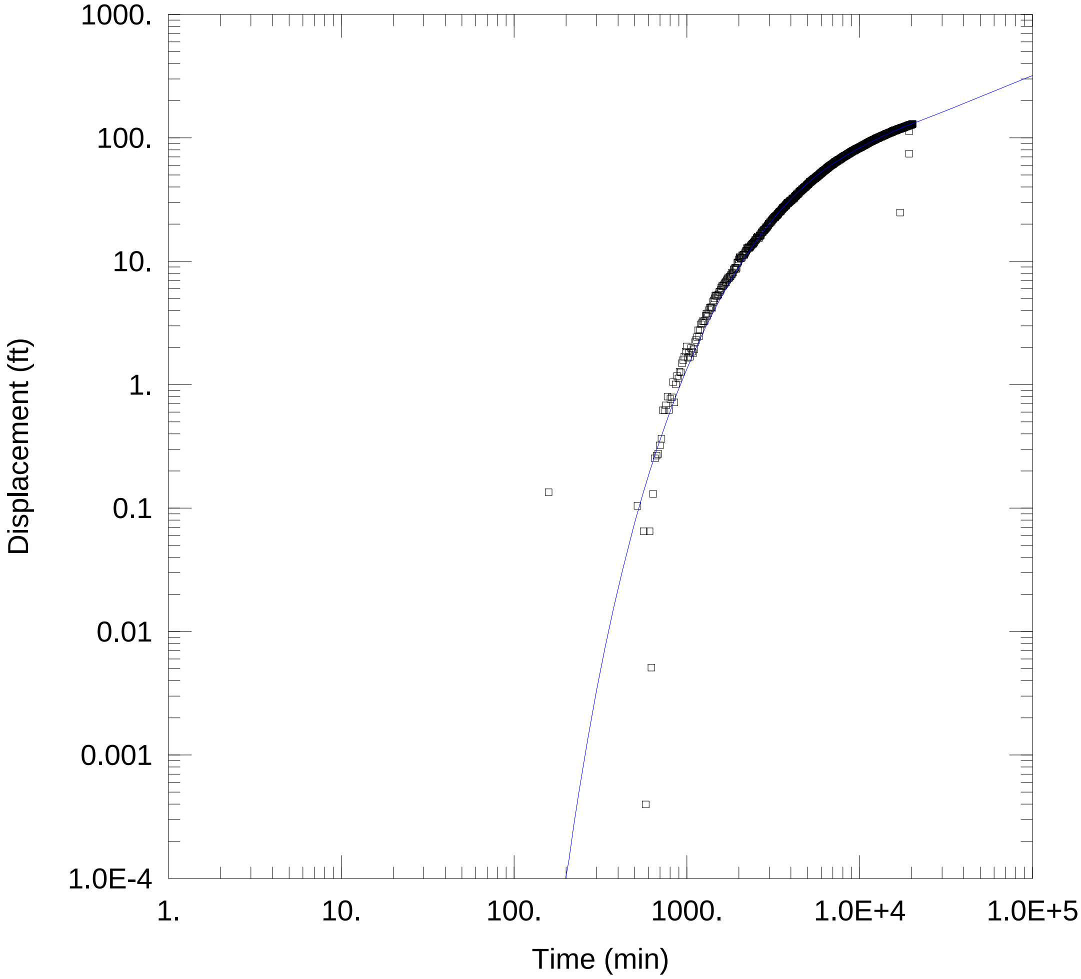
Observation Wells

Well Name	X (ft)	Y (ft)
□ DH 15-14 VW2	-247	50

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 149.3 ft^2/day
S = 1.649E-5
Kz/Kr = 0.0182
b = 100. ft



WELL TEST ANALYSIS

Data Set: K:\project\12020\1602D_PumpTest\AQTESOLV\March 2017 Analyses\DH 15-14_VW1_Theis.aqt
Date: 03/21/17 Time: 12:28:15

PROJECT INFORMATION

Company: Hydrometrics
Project: 12020
Location: Montana Resources
Test Well: MW-16-02D
Test Date: Forward

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
MW-1602 D	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ DH 15-14 VW1	-244	-50

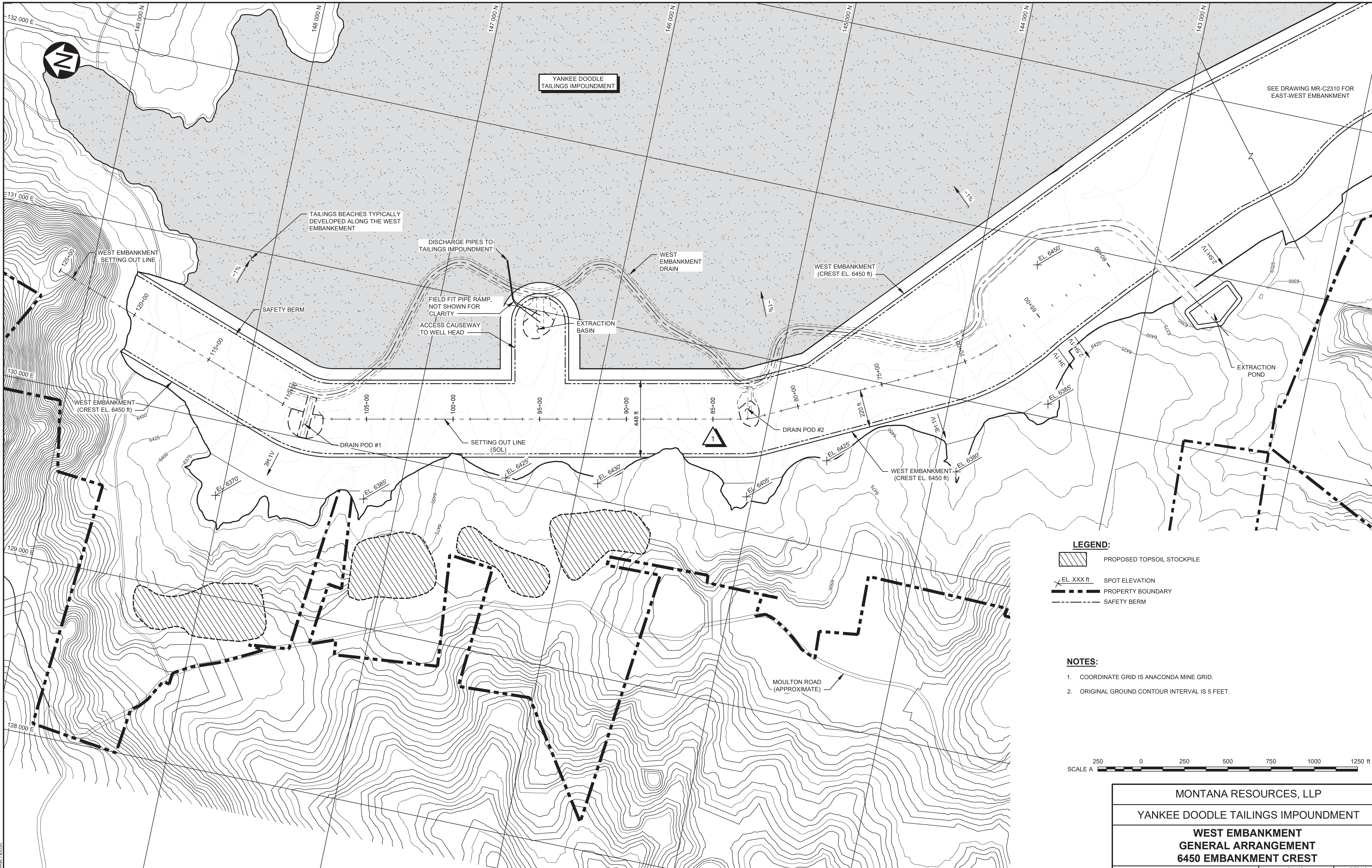
SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 68.64 ft^2/day
S = 3.11E-5
Kz/Kr = 0.001
b = 173. ft

APPENDIX D

UPDATED WEST EMBANKMENT DRAIN DESIGN DRAWINGS (FROM KP, JULY 2017 WEST EMBANKMENT DRAIN DESIGN REPORT, REV. 1)



LEGEND:

- PROPOSED TOPSOIL STOCKPILE
- EL. XXX ft — SPOT ELEVATION
- PROPERTY BOUNDARY
- SAFETY BERM

NOTES:

1. COORDINATE GRID IS ANACONDA MINE GRID.
2. ORIGINAL GROUND CONTOUR INTERVAL IS 5 FEET.

SCALE A: 250 0 250 500 750 1000 1250 ft

MONTANA RESOURCES, LLP

YANKEE DOODLE TAILINGS IMPOUNDMENT

WEST EMBANKMENT
GENERAL ARRANGEMENT
6450 EMBANKMENT CREST

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-126/13	3

FIGURE 3.2 REV 1

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
1	07JUL'17	ISSUED WITH REPORT	JRG	MJC	DDF

SAVED: M:\1\01\00126\13\A\Acad\FIGS\B30_r1, 7/7/2017 2:37:05 PM , MCOUTTS PRINTED: 7/7/2017 2:38:04 PM, FIG 3.2, MCOUTTS
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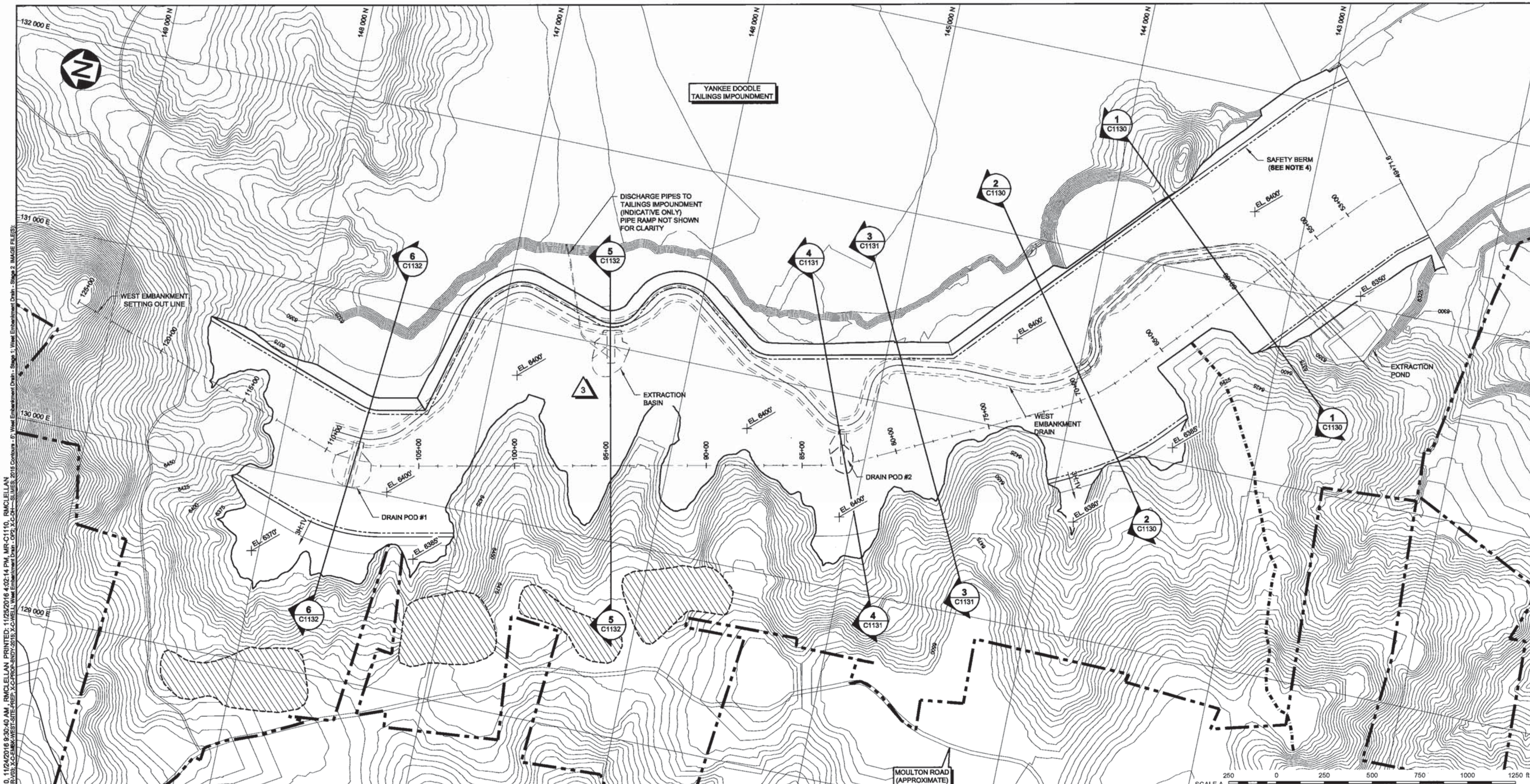

NOTES:

1. THIS DRAWING SHALL BE READ WITH ACCOMPANYING DRAWINGS AND CONSTRUCTION MANAGEMENT PLAN. THE OWNER OR CONSTRUCTOR SHALL IMMEDIATELY CONTACT THE ENGINEER SHOULD UNCERTAINTIES ARISE WITH THE CONSTRUCTION DRAWINGS AND / OR CONSTRUCTION MANAGEMENT PLAN.
2. COORDINATE GRID IS ANACONDA MINE GRID.
3. ORIGINAL GROUND CONTOUR INTERVAL IS 5 FEET.
4. SAFETY BERMS SHALL BE MID AXLE HEIGHT OF THE LARGEST WHEELED VEHICLE.

LEGEND:

- TOPSOIL STOCKPILE LOCATION
- EL. XXXX' SPOT ELEVATION
- PROPERTY BOUNDARY
- CATCHMENT BOUNDARY
- SAFETY BERM

ISSUED FOR CONSTRUCTION

DRG. NO.	DESCRIPTION
MR-C1132	WEST EMBANKMENT - 6400 CREST - SECTIONS - SHEET 3
MR-C1131	WEST EMBANKMENT - 6400 CREST - SECTIONS - SHEET 2
MR-C1130	WEST EMBANKMENT - 6400 CREST - SECTIONS - SHEET 1

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
3	25NOV'16	WEST EMBANKMENT DRAIN UPDATED	JRG	ABN/RM	DDF	KJB
2	20JUN'16	WEST EMBANKMENT DRAIN UPDATED	JRG	ABN/RM	DDF	KJB
1	23MAR'16	WEST EMBANKMENT DRAIN UPDATED	ACR	ABN	DDF	KJB
0	03DEC'15	ISSUED FOR CONSTRUCTION	RSM	ABN	ACR	KJB

REVISIONS

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MONTANA KEN J. BROUWER 10020 PE REGISTERED PROFESSIONAL ENGINEER

Nov 25, 2016

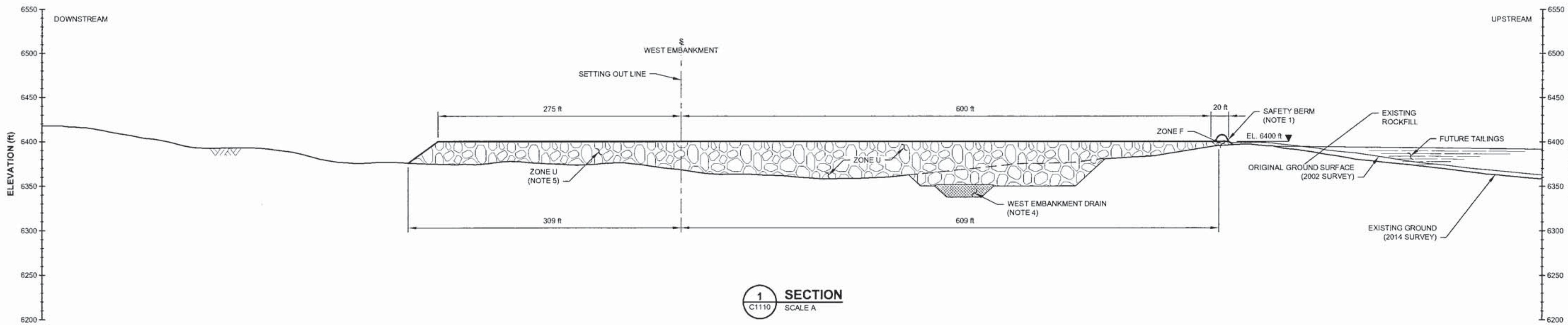
Knight Piésold
CONSULTING

MONTANA RESOURCES, LLP

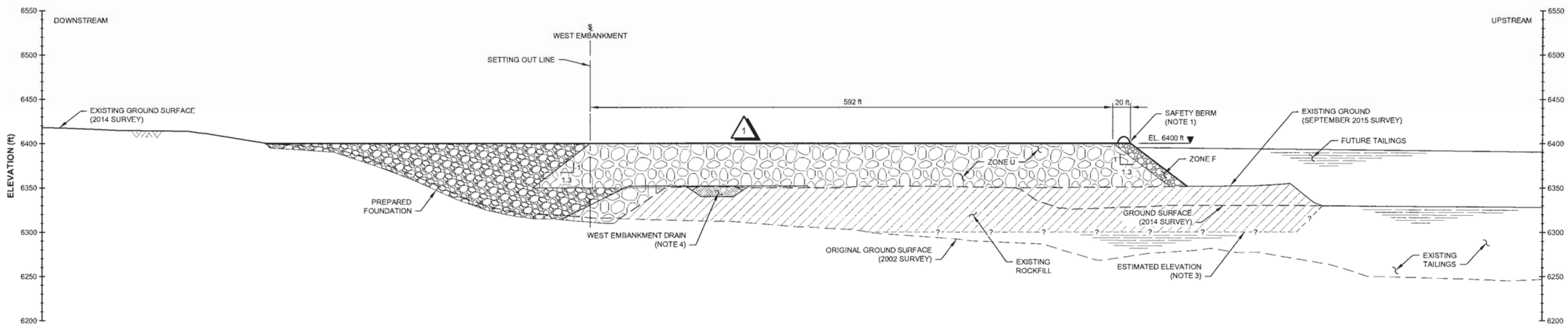
YANKEE DOODLE TAILINGS IMPOUNDMENT

WEST EMBANKMENT
6400 CREST
PLAN

P/A NO.	DRAWING NO.	REVISION
VA101-126/13	MR-C1110	3



1 C1110 **SECTION**
SCALE A



2 C1110 **SECTION**
SCALE A

ISSUED FOR CONSTRUCTION

SCALE A 50 0 50 100 150 200 250 300 ft

LEGEND:

- ZONE F - EARTHFILL
- ZONE U - ROCKFILL
- ZONE D1 - ROCKFILL
- DRAIN POD / EXTRACTION BASIN/ WEST EMBANKMENT DRAIN
- SECONDARY SEEPAGE COLLECTION DRAIN
- EXISTING WASTE ROCK

NOTES:

1. SAFETY BERMS SHALL BE MID AXLE HEIGHT OF THE LARGEST WHEELED VEHICLE.
2. REFER TO DRG. NO. MR-C0011 FOR FILL MATERIAL SPECIFICATIONS.
3. ELEVATION OF EXISTING TAILINGS AND EXISTING WASTE ROCK INTERFACE ASSUMED AT EL. 6300'.
4. WEST EMBANKMENT DRAIN ZONATION NOT SHOWN FOR CLARITY. REFER TO SPECIFIC DETAIL DRAWINGS FOR MATERIALS.
5. ZONE U - ROCKFILL MATERIAL TO BE PLACED WEST OF THE SETTING OUT LINE FROM STA. 49+72 TO STA. 63+00.
6. ZONE D1 - ROCKFILL TO BE PLACED WEST OF THE SETTING OUT LINE FROM STA. 63+00 TO STA. 125+00.

DRG. NO.	DESCRIPTION
MR-C1110	WEST EMBANKMENT - 6400 CREST - PLAN
MR-C0011	FILL MATERIAL SPECIFICATIONS

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
1	23MAR'16	WEST EMBANKMENT DRAIN UPDATED	ACR	ABN	DDF	KJB
0	03DEC'15	ISSUED FOR CONSTRUCTION	RSM	ABN	ACR	KJB

REVISIONS

KEN J. BROUWER 40020 PE
REGISTERED PROFESSIONAL ENGINEER

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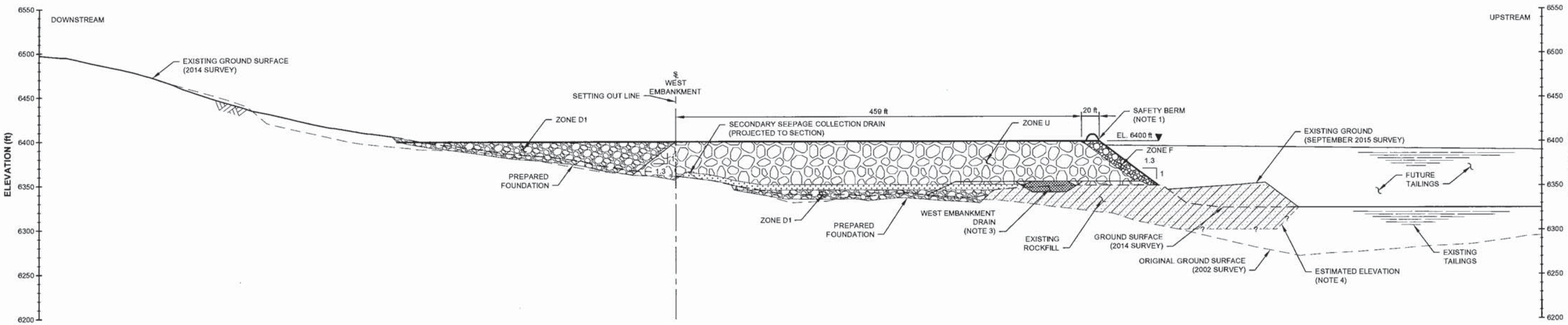
MONTANA RESOURCES, LLP

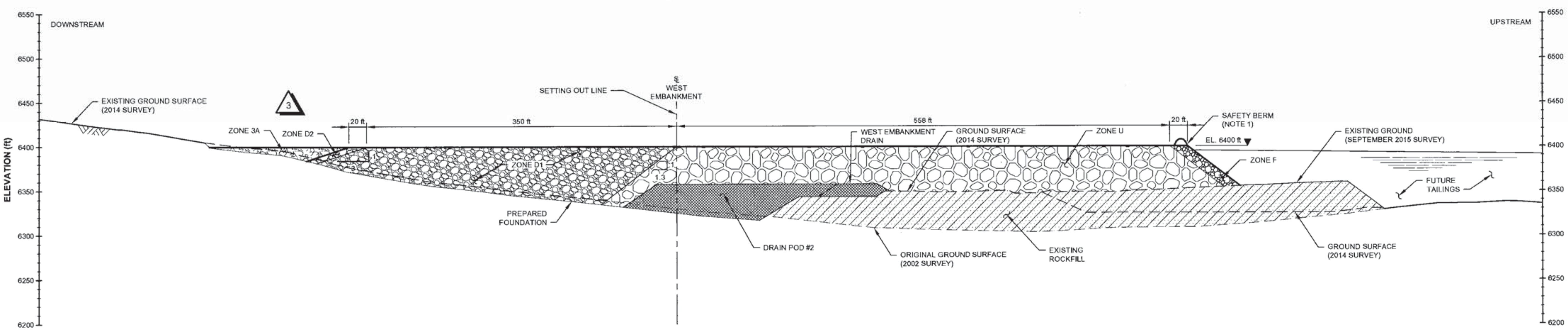
YANKEE DOODLE TAILINGS IMPOUNDMENT

WEST EMBANKMENT
6400 CREST
SECTIONS
SHEET 1

P/A NO.	DRAWING NO.	REVISION
VA101-126/13	MR-C1130	1



3 **SECTION**
C1110 SCALE A



4 **SECTION**
C1110 SCALE A

ISSUED FOR CONSTRUCTION

SCALE A 50 0 50 100 150 200 250 300 ft

LEGEND:

- ZONE F - EARTHFILL
- ZONE U - ROCKFILL
- ZONE 3A - DRAIN ROCK
- ZONE D1 - ROCKFILL
- DRAIN POD / EXTRACTION BASIN / WEST EMBANKMENT DRAIN
- SECONDARY SEEPAGE COLLECTION DRAIN
- EXISTING WASTE ROCK

NOTES:

1. SAFETY BERMS SHALL BE MID AXLE HEIGHT OF THE LARGEST WHEELED VEHICLE.
2. REFER TO DRG. NO. MR-C0011 FOR FILL MATERIAL SPECIFICATIONS.
3. WEST EMBANKMENT DRAIN AND DRAIN POD ZONATION NOT SHOWN FOR CLARITY. REFER TO SPECIFIC DETAIL DRAWINGS FOR MATERIALS.
4. ELEVATION OF EXISTING TAILINGS AND EXISTING ROCKFILL INTERFACE ESTIMATED TO BE AT EL. 6300'.

DRG. NO.	DESCRIPTION
MR-C1110	WEST EMBANKMENT - 6400 CREST - PLAN
MR-C0011	FILL MATERIAL SPECIFICATIONS

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
3	25NOV'16	SUMP AND HOLD CLOUD REMOVED	JRG	RM	DDF	KJB
2	14JUN'16	UPDATED DRAIN POD GEOMETRY	ACR	RM	DDF	KJB
1	23MAR'16	WEST EMBANKMENT DRAIN UPDATED	ACR	ABN	DDF	KJB
0	03DEC'15	ISSUED FOR CONSTRUCTION	RSM	ABN	ACR	KJB

REVISIONS

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MONTANA KEN J. BROUWER 10920 PE PROFESSIONAL ENGINEER REGISTERED

Knight Piésold CONSULTING

MONTANA RESOURCES, LLP

YANKEE DOODLE TAILINGS IMPOUNDMENT

WEST EMBANKMENT 6400 CREST SECTIONS SHEET 2

	DRAWING NO.	REVISION
VA101-126/13	MR-C1131	3

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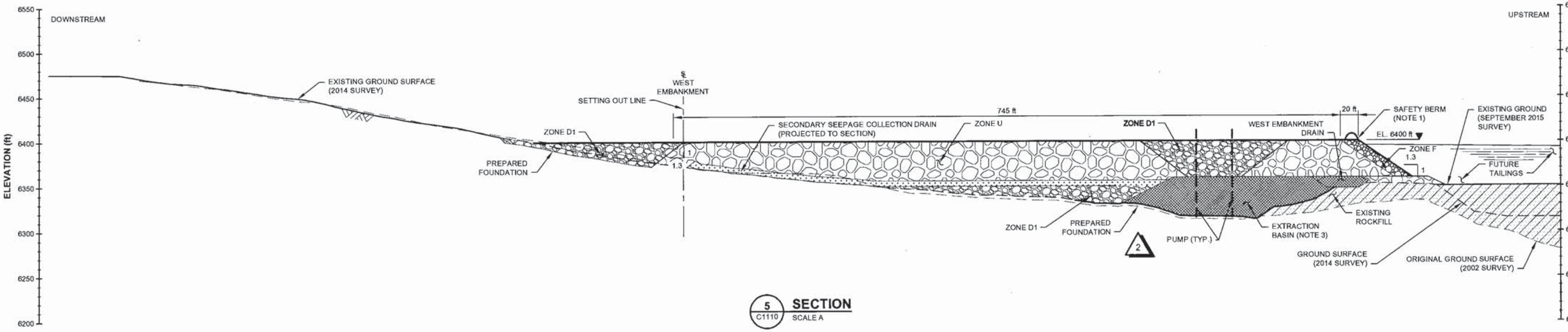
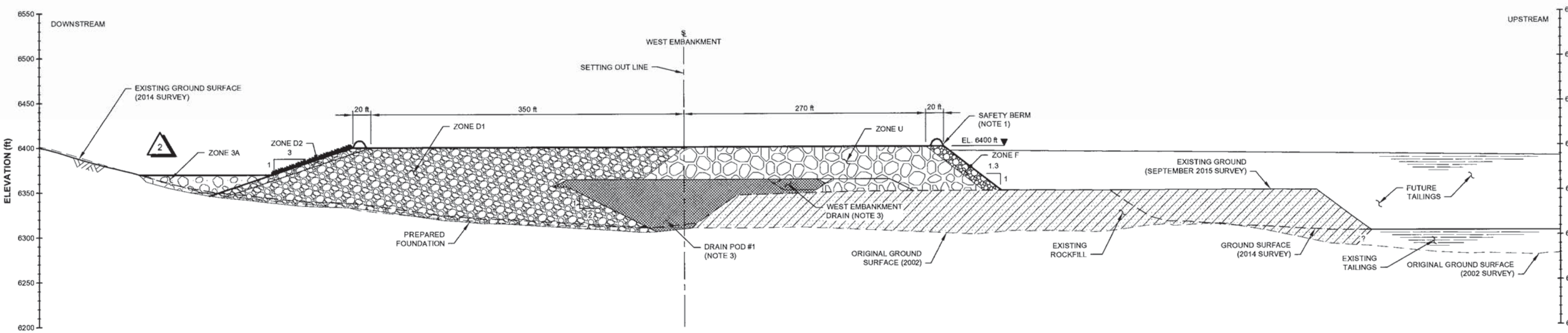


5 C1110 **SECTION** SCALE A



6 C1110 **SECTION** SCALE A

ISSUED FOR CONSTRUCTION

SCALE A 50 0 50 100 150 200 250 300 ft

LEGEND:

- ZONE F - EARTHFILL
- ZONE U - ROCKFILL
- ZONE D2 - EARTHFILL
- ZONE D1 - ROCKFILL
- ZONE 3A - DRAIN ROCK
- DRAIN POD / EXTRACTION BASIN / WEST EMBANKMENT DRAIN
- SECONDARY SEEPAGE COLLECTION DRAIN
- GRASS
- EXISTING WASTE ROCK

NOTES:

1. SAFETY BERMS SHALL BE MID AXLE HEIGHT OF THE LARGEST WHEELED VEHICLE.
2. REFER TO DRG. NO. MR-C0011 FOR FILL MATERIAL SPECIFICATIONS.
3. WEST EMBANKMENT DRAIN, DRAIN PODS AND EXTRACTION BASIN ZONATION NOT SHOWN FOR CLARITY. REFER TO SPECIFIC DETAIL DRAWINGS FOR MATERIALS.

DRG. NO.	DESCRIPTION
MR-C1110	WEST EMBANKMENT - 6400 CREST - PLAN
MR-C0011	FILL MATERIAL SPECIFICATIONS

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
2	25NOV'16	EXTRACTION BASIN UPDATED, MONITORING SUMP REMOVED	JRG	RM	DDF	KJB
1	23MAR'16	WEST EMBANKMENT DRAIN UPDATED	ACR	ABN	DDF	KJB
0	03DEC'15	ISSUED FOR CONSTRUCTION	RSM	ABN	ACR	KJB

REVISIONS

MONTANA
KEN J. BROUWER
10020 PE
Nov 25, 2016
REGISTERED PROFESSIONAL ENGINEER

Knight Piésold CONSULTING

MONTANA RESOURCES, LLP

YANKEE DOODLE TAILINGS IMPOUNDMENT

WEST EMBANKMENT
6400 CREST
SECTIONS
SHEET 3

P/A NO.	DRAWING NO.	REVISION
VA101-126/13	MR-C1132	2

SAVED: M:\1\01\00126\13\A\Acad\DWGS\MR-C1132\MR-C1132, 11/24/2016 9:35:42 AM , RMCLELLAN PRINTED: 11/24/2016 10:26:30 AM, MR-C1132, RMCLELLAN
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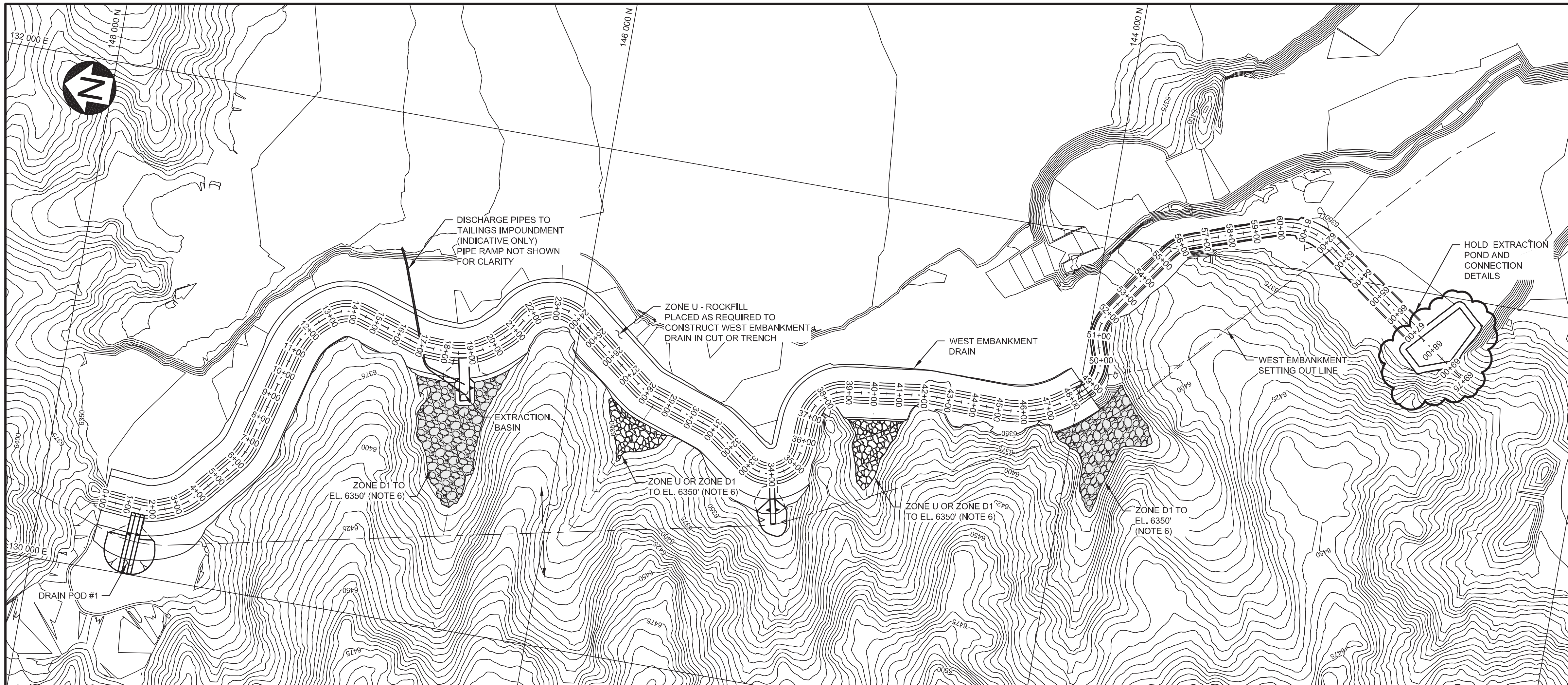
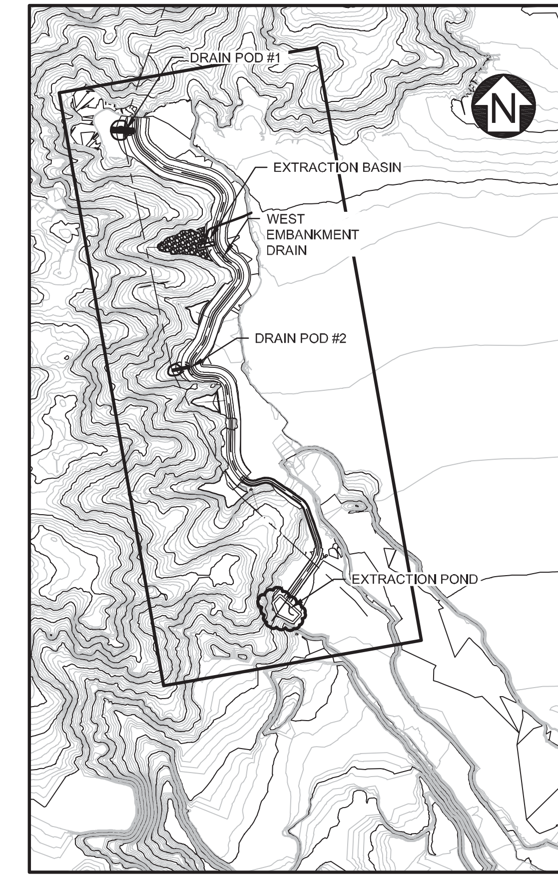
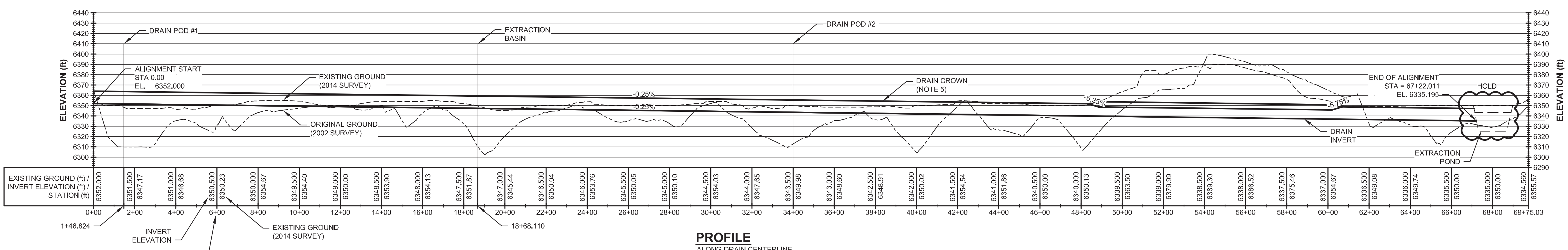


PLAN
SCALE A



KEY PLAN
NTS



PROFILE
ALONG DRAIN CENTERLINE
HORIZONTAL SCALE A
VERTICAL SCALE B

NOT FOR CONSTRUCTION

NOTES:

1. CONTOUR INTERVAL IS 5 FEET BASED ON SURVEY DATA PROVIDED BY MONTANA RESOURCES.
2. DIMENSIONS AND ELEVATIONS ARE IN FEET, UNLESS NOTED OTHERWISE.
3. COORDINATES ARE IN ANACONDA MINE GRID.
4. THE SETTING OUT LINE DEFINES THE BOUNDARY BETWEEN THE ZONE U AND ZONE D1 FOR THE WEST EMBANKMENT. (SEE DRAWING MR-C1110)
5. THE DRAIN CROWN, EXTRACTION BASIN AND DRAIN POD SURFACES REPRESENT THE FINAL GRADE OF THE ZONE 2A - FILTER. THE ZONE UA ROCKFILL HAS BEEN OMITTED FOR CLARITY.
6. INFILL LOW AREAS WITH ZONE D1 OR U WHERE NOTED TO ELEVATION AS NOTED FOLLOWING FOUNDATION PREPARATION.

LEGEND:

ZONE U - ROCKFILL
ZONE D1 - ROCKFILL

SCALE B: 50 0 50 100 150 200 250 ft
SCALE A: 250 0 250 500 750 1000 1250 ft

DRG. NO.	DESCRIPTION
MR-C1110	WEST EMBANKMENT - 6400 CREST - PLAN

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
F	25NOV'16	ISSUED FOR CLIENT REVIEW	JRG	ABN	-	-
E	20JUN'16	ISSUED FOR CLIENT REVIEW	ACR/JRG	ABN	-	-
D	17DEC'15	ISSUED FOR CLIENT REVIEW	ACR	ELG	-	-
C	05OCT'15	ISSUED FOR CLIENT REVIEW	ACR	ELG	-	-
B	14SEP'15	ISSUED FOR CLIENT REVIEW	ACR	ELG	-	-
A	14AUG'15	ISSUED FOR CLIENT REVIEW	ACR	ABN	-	-

REVISIONS

Knight Piésold
CONSULTING

MONTANA RESOURCES, LLP

YANKEE DOODLE TAILINGS IMPOUNDMENT

WEST EMBANKMENT 6400 CREST
WEST EMBANKMENT DRAIN
PLAN AND PROFILE

P/A NO.	DRAWING NO.	REVISION
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EXHIBITS

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana 59601
3020 Bozeman Avenue
(406) 443-4150

HYDROLOGIC EVALUATION OF THE YANKEE DOODLE TAILINGS IMPOUNDMENT WEST RIDGE AREA

SURFICIAL AND STRUCTURAL GEOLOGY OF THE WEST RIDGE AREA

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